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ETI
ELECTRONICS TODAY INTERNATIONAL

ELECTRONICS, COMPUTERS, TECHNOLOGY

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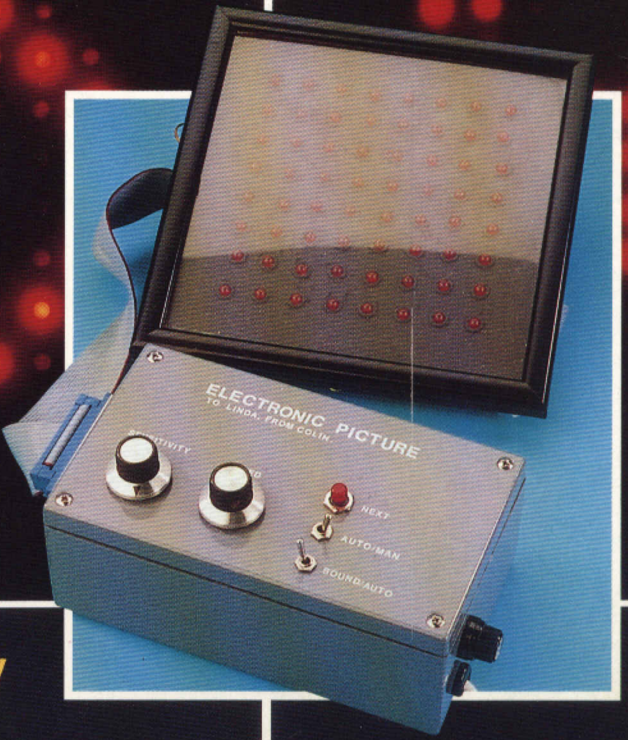
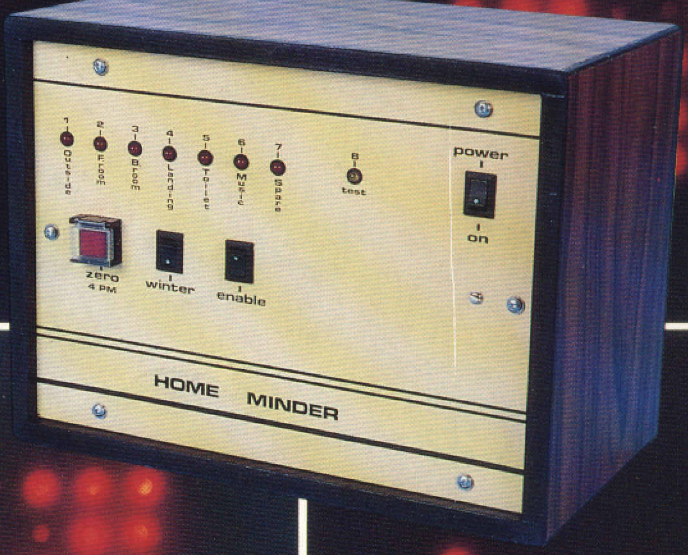


ELECTRONIC PICTURE
A moving LED display

HOT WIRE CUTTER
TRANSISTOR POWER AMP
SEGA BOX



CONTINUITY TESTER
Use the PCB to check out circuits

HOME MONITOR
A Minder to keep the burglars away

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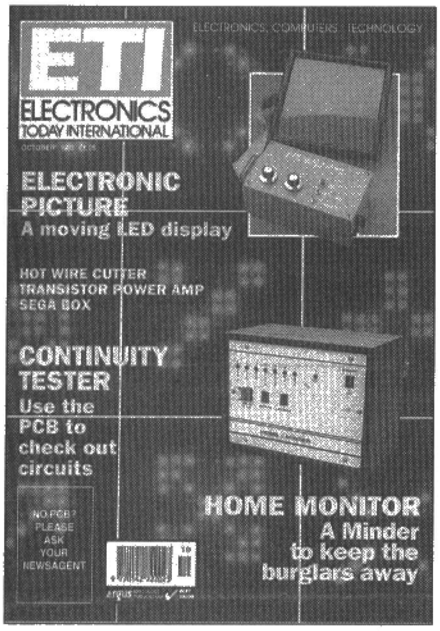

Volume 22 No.10
October 1993

Features & Projects

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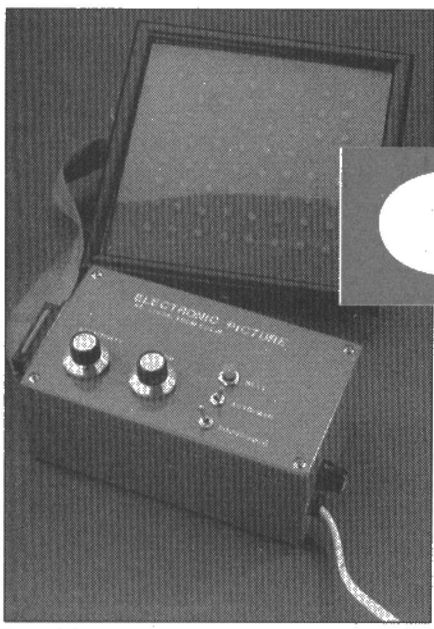

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Regulars

Editorial

by Paul Freeman

It is that time of year again when we issue our Reader Survey. We like to know your comments regarding the magazine in order to steer it in the direction you want it to go. So please fill in the pages and return it to us (postage paid) as soon as you can. Those who reply early will be sent the new Maplin catalogue in return for your efforts.

A time for security?

Home security is very much on our minds these days as a result of rising crime. From this you'd expect the home security business to be a growth area of consumer electronics, and you'd be right.

Providing your own home security can prove an intriguing challenge and also cheap at half the price. This is of course assuming high security is required. Also intriguing is what deterrents could be produced without falling foul of the law. Alternatively you could build this issues' Home Minder to provide a psychological deterrent to any intruder, by making them think someone is in the building.

And finally, it's a pleasure to see a transistor amp project in this issue after all the hype we have seen and heard about valves. Thank you for taking the time to read ETI.

OPEN CHANNEL

There's a whole lot going on in the world of personal telecommunications these days. For a start, I use the term personal telecommunications rather than the synonymous term, mobile telecommunications.

CB started the personal telecommunications revolution because once users felt the benefits of being able to communicate from the wheel, they began to question why this couldn't apply to other situations. Its great being able to chat with others in the immediate area - but wouldn't it be so much better if it could be as a connection into, say, the public telephone system. Then a mobile user could call up (or receive calls from) anyone else in the world who has a telephone or a similar mobile communications device.

Cellular telephony allows this and various systems have been set up in the UK (Cellnet and Vodafone) as well as in Europe and around the world. They all share the same basic philosophy of having literally hundreds of small local base transceivers picking up signals and retransmitting them to and from other base transceivers or users.

Another mobile phone service known as CT2 (Cordless Telephone type 2) has started up recently in the guise of telepoint, with the only surviving telepoint system known as Rabbit, operated by Hutchison Telecom. However, Rabbit handsets can't receive calls, and outgoing calls can only be made within a strictly limited range (within 200 metres) of a base station. Handsets and calls are, however, much less expensive than those of existing cellular systems.

Cellphones, in their original state, were generally mobile devices, simply because power requirements in the old days meant that a high-current 12V supply was needed for the output power. Over the last year, low-current low-voltage cellphones have become commonplace, giving users access to totally portable and pocket-sized cellular telephones.

Around 80% of cellphones currently sold are of this hand-held category, which signifies a general move from mobile telecommunications to those of a more personal nature. In the UK both Cellnet and Vodafone are tremendously successful. Vodafone is expecting to sign up its millionth customer at the beginning of next year. With user-numbers like this, it's important for us all to see that personal telecommunications - with the accent on personal - is a big thing, and not just a flash in the marketing departments pan. When the landline telephone was invented there were probably people who said it would never catch on, too. Like it or not, personal telecommunications is here and is set to stay in no small way. If you haven't got a personal handset yet, you will have!

Cellular systems in this current category are of an analogue nature and analogue electronic devices are generally destined for the scrapyard. Sooner or later digital devices will take their place, with higher quality and less expense. Cellular systems have their limitations though. For a start, they are fast approaching their maximum numbers of users. Each communication channel has quite a large bandwidth requirement which means only a limited number of channels can be allocated within any given frequency slot. Secondly, analogue systems are prone to interference and speech quality problems. Thirdly, they are still expensive with only businessmen and well-to-do consumers able to afford them.

Already starting operation are the latest forms of personal telecommunications, operating on the cellular basis of small local base transceivers but in a digital manner. Being digital, communications between users are less liable to interference and with high-quality audio. Eventually the hand-held or mobile will be cheaper than their analogue counterparts.

The digital networks involved in these cellular systems are of two types. First is the global system for mobiles (GSM) network in which all connected users are able to access any phone or cellular user world-wide with high digital quality. Not only can this be done in the country where the unit was purchased, but in any country which also has a GSM network. Such inter-country usage is called roaming and current analogue cellular systems don't properly allow it. Greater numbers of users can be connected, too, sufficient for every current telephone user to have at least one. Vodafone has the first GSM in the UK, called EuroDigital.

The second type of digital cellular system to start is the personal communications network (PCN). First off the ground here are Mercury's One-2-One and Vodafone's MetroDigital. A third, operated by Hutchison Telecom, will start next year and others may be allocated the following year.

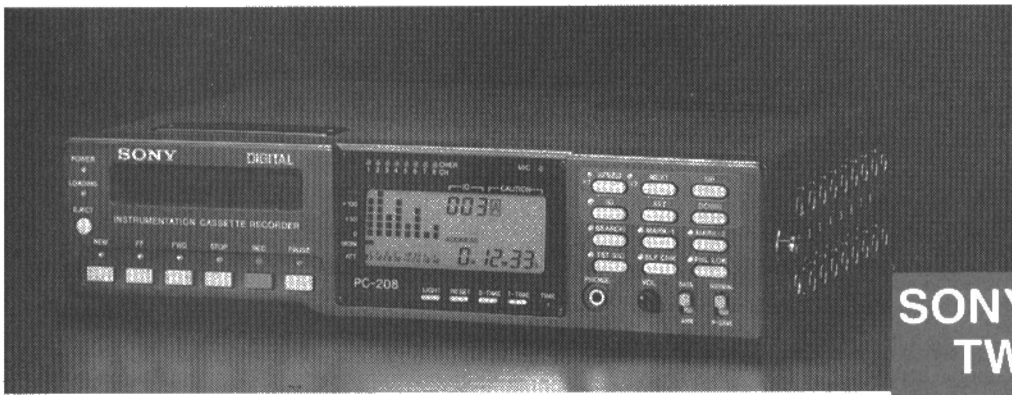
There are several similarities between PCNs and GSM, apart from the obvious that they are both digital. However, it's their differences which are most important. PCNs are envisaged more as local networks, aimed at the mass consumer market, while GSM networks are considered to be for the more business-oriented user who travels internationally.

Interestingly, it looks like handsets used on GSM and PCN networks will be interchangeable, with premium charges, on GSM networks. Pricing, as it happens, is an important consideration. PCNs are set to be considerably cheaper than current cellular systems, while GSM networks should eventually end up at around the same as current systems. Its the price which will make or break the systems, after all. Cheap enough and consumers and business users alike will be falling over themselves to get a handset connected to the respective networks. Too pricey (or no cheaper than current cellular prices) and what's the point? Its going to take a year or two until the PCN and GSM networks are fully up-and-running, so customers might stick with analogue systems for a while too, to avoid confusion.

Over the last year, current analogue networks have already begun the two-tier strategy with a cheaper connection arrangement (alongside higher call charges) for consumer users - Cellnet's Lifetime, and Vodafone's LowCall. Now the two-tier pricing has been introduced and is understood by users, PCNs and GSM networks should widen the differential even more. Business users can have their world-wide telephone conferences at one price and consumers in the mass market at another, a lower price. And all of this can be achieved without recourse to an existing landline telephone.

Keith Brindley

ETI NEWS



SONY ANNOUNCES TWO NEW DAT BASED INSTRUMENTATION RECORDERS

Sony has launched two new instrumentation Data Recorders, the 4 channel PC-204A and 8 channel PC-208A. These models offer better features over their predecessors the PC-204 and PC-208, but are available at the same price.

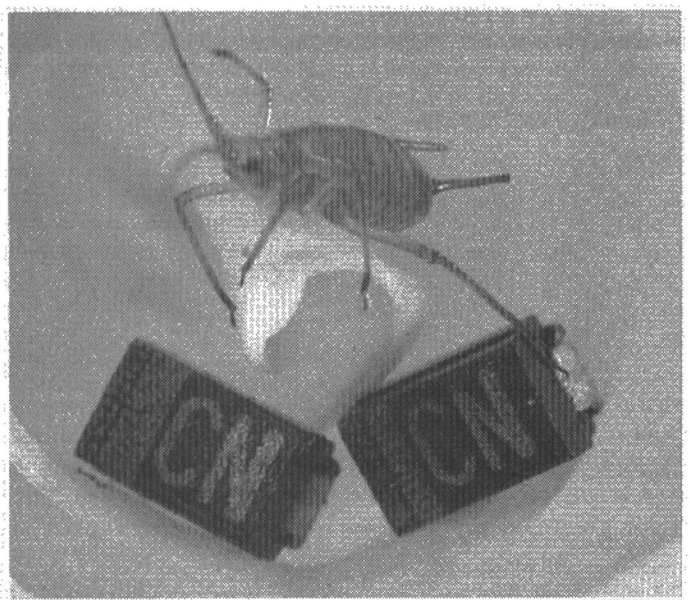
The PC-204A and PC-208A offer Double Bandwidth recording and playback at 80kHz, which can be split into four 20kHz or eight 10kHz channels. A wide 'dynamic range of over 80dB allows the capture of signals in noise-critical environments such as acoustic noise measurement.

The employment of DAT technology makes the equipment suitable for high density storage as it offers more than ten times the capacity of standard audio cassettes.

In addition to the four or eight available channels there is a digital I/0 channel which uses the LSB (Least Significant Bit) of each data word. This allows for the recording of binary signals such as rotational and stimulus pulses as well as timing or reference signals.

The PC204A and PC208A can also be used as serial digital recorders with input and output capabilities of up to 3.072 Mbits/sec. A high speed parallel digital output enables 16-bit transfer of data to computer platforms.

Another feature of the Sony Data recorders is the use of PCM (pulse code modulation), a measurement technique which guarantees the accuracy of logged data. By converting the analog signal levels into numeric values and recording them digitally, it avoids the risk of corruption by magnetic tape or tape transport mechanisms.



SMALLEST CHIP CAPACITORS

NEC Electronics' new range of ultra-miniature tantalum chip capacitors are claimed to be the smallest available for their capacitance value range.

The SVS series, which ranges from 0.33uF to 2.2uF with voltage ratings of 2.5 volts to 16 volt DC, have outline dimensions of only 2.00mm x 1.20mm x 1.25mm - half the size of the EIA standard A case.

These new products complement NEC's existing R-series tantalum chip capacitors which range in value from 0.047uF to 330uF with voltage ratings of up to 50 volts DC.

All of the SVS series of products operate over the -55°C to +125°C temperature range with a tolerance of 20%. Leakage current is 0.5uA maximum with a dissipation factor of 0.1 max. The capacitors are available in tape reel format and pricing is £0.12 in 1,000 piece quantities.

COMMUNICATION GAP IS HOLDING BACK INDUSTRY

Research released at the Computers in Manufacturing Show (CIM '93) reveals a communication gap between Information Technology suppliers and manufacturers that is holding back UK industry, according to John Puttick, Director of Manufacturing Europe for PA Consulting.

The research undertaken on behalf of CIM '93 by Benchmark Research shows that manufacturers remain unconvinced, and distrustful, of the benefits of IT and revert to manual methods during critical production runs. 33% of managers from large and medium sized manufacturing plants revert to manual methods when scheduling rush jobs, 43% still believe manual methods are more suited to control shopfloor processes and 21% are convinced that manual methods are better for scheduling production.

However, users universally accepted that computers were able to manage accounts, sales orders, purchase orders and stock control better than traditional manual methods. Another 51% admitted they did not actively measure the success of computer investments unless a problem emerged.

John Puttick from PA Consulting Group commented: "Manufacturers are so caught up in the chaotic world of the factory floor that they're unable to define their problems adequately, let alone explain them to anybody else. While, IT suppliers do not understand the complexities of manufacturing and are unaware of the limitations of the technology. The result is that IT suppliers can 'over-sell' the capabilities of the technology and some manufacturers can become disappointed and disillusioned with IT and its suppliers.

"This gap is holding back technological development within UK manufacturing. Our manufacturing industry is based on the production of capital goods, such as aerospace components, luxury cars and gas turbines. These goods require constant modifications, testing and manufacturing. What is needed is a system that can 'think' in a flexible way, while coping with complex tasks. The UK has the opportuniry to do for capital goods what the Japanese have done for high-volume products, but the adoption of IT is critical.

Alec Cassells, Systems Consultant for IBM Industrial Con-

sultancy agreed that there were problems to be solved, but sees this as an opportunity for customers and supplier alike.

"The fact that most of the users only measure the success of their computer systems when a problem emerges demonstrates that they don't have an accurate idea about the successes they are achieving," Cassells said.

The Computers in Manufacturing Show 1993 (CIM '93) is now commissioning a greater study into the attitudes held by manufacturers, IT suppliers, management consultants and the media, to look at ways of overcoming this communication problem.

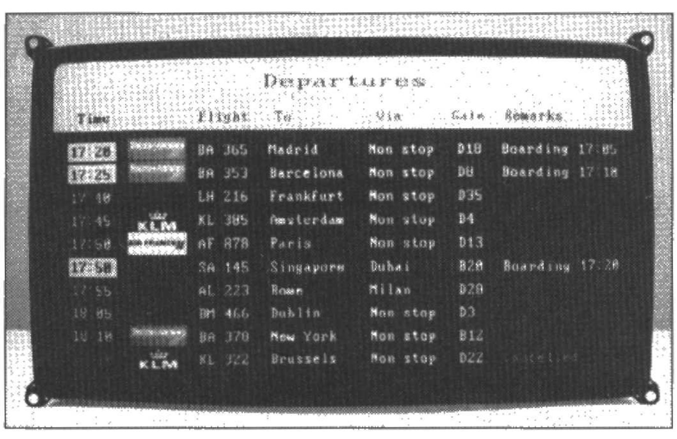
CIM '93 will be held at the National Exhibition Centre in Birmingham from October 19-21.

NICAD UNIVERSAL CHARGER

MAPLIN Electronics can now supply a NICAD UNIVERSAL CHARGER priced at £9.95 (incl VAT). The Nickel-Cadmium battery charger is capable of charging AAA, AA, C, D, PP3 and rechargeable button cells singly or simultaneously in varying combinations. There are two charge sockets for PP3 batteries and either one or two may be charged together. There are two positions where AA, C or D cells may be charged. In addition there are two positions for rechargeable button cells, diameters 16mm, 11.6mm or 8mm. (Note: It is very dangerous to attempt to recharge mercuric oxide, zinc-air or silver oxide cells). All ten charge positions may be used simultaneously or in any combination. Each of the eight main charge positions (ie. not the button cells) has an LED associated with it which lights when charging is in progress. In addition, three test positions are provided, one for AAA and AA, one for C and D cells and one for PP3 batteries. When the charging switch is off, depressing the test button for the test position in use allows the meter to show if the battery is flat. The unit has 1.7m mains lead. Overall size: 185 x 155 x 56mm.

SPECIALLY COATED MONITOR SCREENS

Philips Components latest screen coating for monitor screens has given the company the leading edge in information display applications.



The anti reflection/anti static screen coating (ARAS) which cuts light reflections on monitors to just 0.5% - a mass twentyfold drop compared with uncoated screens.

The anti-reflection/anti-static screen coating (ARAS) cuts light reflections on monitors to just 0.5% - a twentyfold drop compared with uncoated screens.

The special coating is made of a multi-layer structure of transparent dielectric material that suppresses specular reflections by broad band interference effects at the screen surface. The anti-static properties are provided by a single conductive layer within the multi-layer structure.

Philips Components has recently won a major contract to supply Amsterdam's Schiphol airport with these specially coated monitor screens which cut light reflections by 90%.

Schiphol has just ordered 400 coated screens and plans to equip each of its 2000 flight information displays with the coated monitors by the end of 1994.

ARAS coating is available as an option on 66cm (28 inch) Flatter, Squarer Monitor Tubes type M66EEU418X and 16:9 ratio displays.

MD DATA STANDARDS FOR COMPUTER DATA STORAGE

Sony has announced the development of standards for MD DATA, the new compact data storage medium offering high data stora capacity for personal computer applications.

The MD DATA standard has been developed to meet the computer industry's growing need for storage media capable of handling large amounts of data. The standard is based on specifications recently established for MiniDisc personal audio system, which Sony introduced in November 1992. Sony will offer the new MD DATA standard to computer and other manufacturers to generate industry support.

Typically, floppydisks have been the medium of choice to fill the everyday data storage needs of personal computers because of the disks compact size and cost effectiveness. However, the need to add graphic as well as audio information to documents created on a PC led to the demand for a removable data storage medium capable of handling larger amounts of data. While magneto optical (MO) discs are currently being used to meet these needs for workstations, Sony believes that factors,such as system size cost and ease-of-use will make MD DATA products widely accepted by consumers seeking portable computing applications.

MD DATA is expected to evolve into the next generation in data storage technology. Offering the cost-effectiveness and user-friendliness of floppydisks, MD DATA will also provide several special features including, a small portable size, 140MB memory. capacity2,000 frames of still color images on one MD DATA disc;

It also allows a data transfer rate of 150kB per second, enabling

CD full motion video;

Importantly, a new file system, which determines how information is encoded ont the disc, has been developed as part of the MD DATA stc lard to facilitate compatibility between computers

based on fferent operating systems (0S).

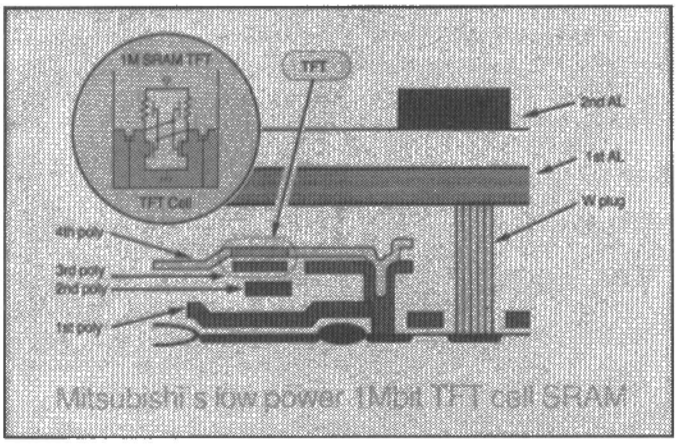
Computers using different CPUs and/or OSs employ file systems unique to their standard. these file systems determine file structure and the manner in which data is written onto the disk. As a result, it is difficult to interchange floppydisks between computers of different platforms.

The MD DATA' s file system ill circumvent this problem. Once MD DATA system software is installed onto the computer, information written onto MD DATA discs can be retrieved and modified regardless of differences in the CPU and/or 0S of the computers being used.

Specifications:

*Recording Capacity:	140 MB (maximum)
*Sector Size:	2,048 bytes
*Data Units	64 kB
*Data Transfer Rate	150 kB/sec
*Cartridge Dimensions	68 mm x 72 mm x 5 mm
*Disc Diameter	64 mm
*Disc Thickness	1.2 mm
*Track Pitch	1.6
*Laser Wavelength	780 nm
*Numerical Aperture	0.45
*Recording Method	Magnetic Modulation Overwrite System
*Linear Velocity	1.2 m/sec-1.4 m/sec
*Modulation System	EFM
*Error Correction System	Adaptive Cross Interleave Reed Solomon Code (ACIRC)

VERY LOW POWER SRAMS



Mitsubishi's low power 1Mbit TFT cell SRAM

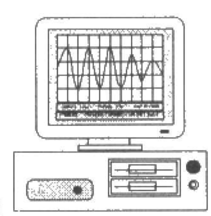
Mitsubishi has announced the expansion of its second generation 1MBit, low power SRAM product family. A new TFT (thin film transistor) cell version of the 1Mbit SRAM has been produced using 4Mbit technology to achieve superior power saving performance. Indeed, the new TFT device is the lowest power 1MBit SRAM currently available.

The 1MBbit TFT cell SRAMs, like the other 1MBit SRAM products, operate at 3V (2.7 to 5V range) giving increased battery life. The SRAMs are useful in portable applications ranging from computers and dataloggers to mobile communications equipment. The low power devices are also ideal for memory card type appplications where battery backup is used to give portable, non-volatile mass data storage.

The new TFT devices can be used in a 2Mbyte memory card, providing a ten year life from a single 3V standard lithium cell.

The 1Mbit TFT series SRAMs typically consume 0.05µA on standby from a 3V supply compared to 0.3µA from current HR cell devices. The new TFT cell device is downward compatible with previous HR cell 1MBit SRAMs and is organised as 128k x 8bit.

MORE NEWS NEXT MONTH



ETI NEWS

...Stateside...

Protecting gas furnaces from power cuts

During a sustained power cut, even people with gas furnaces may be without heat because electricity is needed to operate the blower. Petrol and kerosene-powered generators may be used for backup power, but they must be watched and maintained and mean that potentially dangerous fuel must be kept around the house.

Rochester Gas and Electric, of Rochester, New York, has sought help from the GE Research and Development Centre in Schenectady to solve this problem. The GE centre has now demonstrated the viability of a continuous gas furnace, which converts gas heat into electricity to power the blower and accessories. The key is a small thermoelectric generator that could be incorporated in new furnace designs. The generator exploits the Seebeck effect, where a circuit made of different materials (a thermocouple) will generate electromotive force (voltage) when its two junctions are kept at different temperatures.

The prototype furnace, a small, 70lb unit burning diesel fuel, produced 7.2kW or 25,000 BTU/hr of heat, about one-quarter the output of a typical home heating system. In tests, the unit also produced 160W of electricity, approximately 60W of which were needed to run the heating system. This left 100W of auxiliary power. A full-sized gas system could produce around 600W of energy without reducing heat efficiency. However, economics dictate a production system with fewer thermocouples, which would produce 100W to 300W of electricity.

Volume holographic storage

Although still in the research stage, volume holographic storage for computer software has recently required its own data compression technique, called fractal space multiplexing.

The technique was tried recently at Northrop Corp.'s Electronic Systems Division, where a demonstration project stored a record 5,000 holograms in a lithium niobate crystal. Without the fractal geometry, the crystal could only support 500 holograms with reasonable resolution.

Holographic techniques already perform a kind of data compression. A two-dimensional array of pixels can be represented as a one-dimensional array of reference beams. The two-dimensional image is reconstructed from a wave interference pattern, generating the reference beams.

That fractal geometry multiplexing would save space seems to be paradoxical at first, since it requires several one-dimensional reference-beam arrays that would therefore take up more information storage space in the crystal. A large gain in storage occurs on read out, however, since the added information greatly reduces the optical crosstalk between stored images. The reduction in noise results in the ability to store 10 times as much information in the same space.

New microprocessor speeds pose problem

Now microprocessor speeds are moving above 100MHz, problems normally associated with radio-frequency design are beginning to intrude into digital systems. Several projects aimed at solving system communication bottlenecks with optical methods have converged on a little-known area of organic chemistry - long-chain polymers, to which optically active molecules known as chromophores are attached.

Researchers believe the polymer materials may not only be the key to uncorking future bottlenecks but could also lower the cost per bit of information transmitted by orders of magnitude.

At cycling rates above 100MHz, electromagnetic interference, terminal echo and ground bounce start to disrupt the simple capacitance model of interconnecting wires. While those unwanted effects complicate current designs, they threaten to become an insurmountable obstacles at the inter-chip level.

Polymer-based materials are attractive because they solve a crucial materials-compatibility problem that has plagued other electro-optic approaches.

Compound semiconductors such as gallium arsenide or indium phosphide are star performers, but crystalline mismatch with silicon has effectively blocked attempts at integration. The same is true of ceramic E-O materials. Lithium Niobate, for example, is preferred for its strong electro-optic performance but, as a crystal, is similarly difficult to integrate with other crystalline materials.

GE research has turned up a new candidate - dimethyl amino stylbazolium tosylate (DAST) - which the project is targeting for use as a thin-film interconnect technology for multi-chip modules. DAST has an unusually strong electro-optic coefficient, which makes it ideal for shrinking the size of devices.

In general, organic polymers tend to have weaker E-O coefficients than crystalline materials, and they also suffer from stability problems.

The new material discovered at GE has an unusually high E-O coefficient, but keeping that value stable over wide temperature ranges and long operational periods is proving difficult.

High temperature superconductor

Superconductor Technologies Inc., of Santa Barbara, California, has constructed what it believes is the first high-temperature superconductor delay line longer than 100 nanoseconds.

Made of a thallium-based HTS, the line is drawn in a module that measures only 3.8 ∞ 3.8 ∞ 0.5in. It would replace 70ft of RG-141 stainless steel coaxial cable in instrumentation and electronic warfare-delay applications.

Compared with the coax line, the HTS delay line improves insertion loss by a factor of 5, which enables a system designer to reduce the number of amplifiers needed to recover a signal, improving signal integrity.

The choice of 100 nanoseconds was more or less arbitrary, though within a certain window. The company thinks there is a competitive advantage with superconductors with delays between 25 and 500 , before optical systems become more optimal.

The delay line could be useful for storing signals in channelised receivers while a superheterodyne is being tuned.

Simulated Annealing

Exatech Software of Colorado Springs, has announced an add-on that applies simulated annealing, a neural-like learning method, to spreadsheets.

It can quickly locate minima or maxima in problems involving too many simultaneous equations or unaccelerated PCs.

Called XSolver, the programme has been designed for use with Microsoft's Excel spreadsheet. It communicates directly with Excel via Windows' dynamic data exchange method.

Simulated annealing simulates the way that the temperature is repeatedly raised and lowered on an annealing furnace. For microchips, annealing helps form a perfect crystal lattice.

XSolver's user interface presents the user with the control panel on an annealing furnace while the spreadsheet data undergoes the annealing. The model, must first be expressed as a spreadsheet, with the user declaring the spreadsheet cells that contain adjustable parameters and the value in the single cell, which is a function of those parameters, to be minimised.

The user can choose whether thermal changes alter the values of individual cells or a swap in values between random pairs of cells.

Hot Wire Cutter

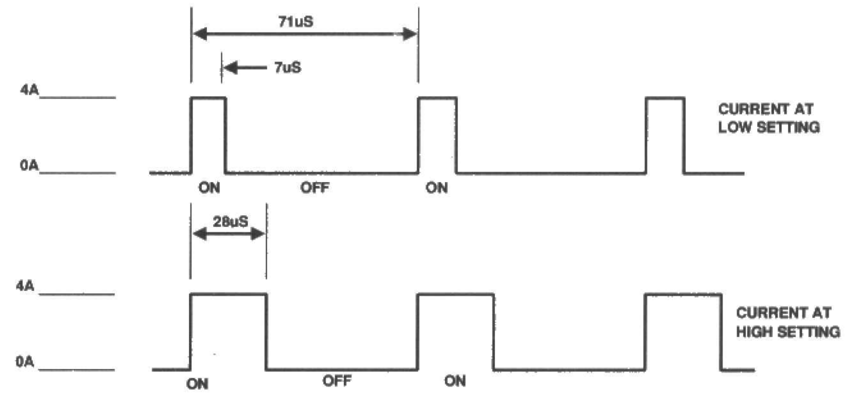


Fig.1 Current through cutting wire

Colin Meikle describes a useful instrument for cutting shapes

This piece of equipment will easily find a home on the work bench. Anyone who builds electronic projects has undoubtedly spent many hours drilling, sawing and filing boxes to accommodate meters, connectors, displays, etc.. This piece of equipment is a controllable hot wire, which can be used to cut detailed shapes out of plastic enclosures (or can be used anywhere plastic or even polystyrene requires cutting). The equipment consists of three separate parts, a Power Supply, the control electronics and a 'U' shaped handle which has the cutting wire. The circuit incorporates a temperature control, which is essential to be able to cleanly cut different thicknesses and cut at different speeds. A Tricoloured LED gives an indication of the cutting wires temperature (green = cool, orange = warm and red = hot). Touch strips are incorporated in the handle of the cutting arm, so that the hot cutting wire is only turned on when the handle is being held (this helps avoid the inevitable burnt fingers). The circuit as described has been designed to operate from a 12V PSU, such as the power supply for a PCB drill (see the section on Power Supply).

There are a number of ways of controlling the power to the hot wire and hence the temperature of the wire. The method employed in this circuit is Pulse Width Modulation, which is a very efficient method. The power to the hot wire is pulsed on and off and by varying the on/off period, the temperature of the wire can be controlled. Figure 1 shows the output waveform to the hot wire. The current through the wire when it is on is approximately 4A and, from Figure 1, it can be seen that the duty cycle is between 10% and 40%. A bulk capacitor supplies the peak current and hence the current which is drawn from the supply is between 0.35A and 1.5A. Since the wire is either on or off, the losses in the circuit are very small. A MOSFET was chosen for the output transistor due to its very small on resistance (0.18R), hence it can operate without a heatsink. The circuit's operating frequency is not critical, although a few factors must be taken into consideration. As the wire is continually pulsed on and off, it is constantly heated and cooled. This causes the wire to expand and contract which in turn causes the wire to vibrate a small amount. This vibration at low frequencies manifests itself as an audible hum, which can be annoying. At very high frequencies the circuit becomes less efficient, as losses in the output transistor will start to increase. Another factor to consider at high frequencies is Electromagnetic Emissions. At high frequencies, with large switching currents the emissions from the circuit could easily interfere with other electronic equipment. With the components specified the operating frequency is between 13-15kHz.

Component Selection

The most important component is the cutting wire itself. The wire used was salvaged from the heating element of an old hair dryer, one element will give years of supply. (I have used the wire from two different elements, both had a resistance of approximately 3 ohms per 10cm). It is not critical that the wire has the same resistance, as the duty cycle of the circuit can be altered to compensate for different wires, but wire with a significantly lower resistance should not be used.

The MOSFET specified can be substituted for any Power MOSFET which has a low On resistance (less than 0.25R). Any device which has a higher On resistance may require a heatsink - if alternative devices are used, check the pin out.

Resistor 9 is not strictly required, but it does allow the current through the circuit to be easily monitored, thereby allowing you to check that your PSU is not over-loaded (current = 4 ∞ Voltage across R9). The wire used between the control unit and the handle should be the 'Extra Flex' type, to allow free movement of the handle. Ensure the connectors used to connect the wires the handle are capable of handling over 4A.

Power Supply

The circuit has been designed to work from any 12V power supply that can supply 2A or more. Standard batteries are not a suitable source for the supply, due the high current

PROJECT

HOW IT WORKS

Operation of the circuit is very simple, referring to the circuit diagram (Figure 2).

The circuit is based around a free running oscillator with a variable duty cycle. This oscillator consists of IC1c and associated components. D1 and D2 allow the charge and discharge path for C2 to be separated. By altering RV1 (or R3 and R4) the charge and discharge time for C2 can be altered and hence the duty cycle of the oscillator is altered.

The oscillator signal drives the red segment of the tricoloured LED and its complement drives the green. As the duty cycle is increased the red segment is driven more and the green less, thereby giving an indication of the temperature. Note that R7 and R8 are not equal because the maximum duty is 40%, therefore the green segment is driven longer than the red. To compensate for this, the series resistance for the red segment is lower than for the green.

The oscillator signal is ANDed (IC1a & b) with the TPAD signal, before driving the output transistor. The TPAD-2 signal is pulled low via a very high resistance (R1). When the handle is held the touch strips are 'shorted' and TPAD-2 goes high (since the skins resistance is much lower than R1). This allows the oscillator signal to drive the output transistor, Q3, which in turn drives the cutting wire.

C6 smoothes out the high current pulses, resulting in a steady current being drawn from the supply.

drain of the circuit, however rechargeable batteries with a high capacity could be used (e.g. lead acid). Figure 2 gives details of a suitable supply if building your own.

Note: Any power supply over 6V (>24VA) can be used. If lower voltage supplies are used R3, R4, R7 R8 will have to be altered, to increase the duty cycle.

Construction

The component layout for the PCB is given in Figure 3. The finished PCB should be mounted in a small box and 'wander' type connectors are ideal to connect the wires from the cutting arm to the control box. Figure 4 shows the dimensions for the U shaped cutting arm, although there is nothing critical here and you may wish to design your own. The length of the actual cutting wire should nevertheless be kept to a similar length.

As can be seen from Figure 4, the handle of the arm is a 18mm² block of wood. The arms are two equal lengths of dowel rod, which can easily be glued into two holes drilled in the handle. Drill all the required holes in the dowel rod before gluing them in place (remember to ensure all the holes line up). Metal tubes should be used to stop the wood from burning where the cutting wire passes through the wooden arms and I used uninsulated bullet type connectors for this. It will sometimes be necessary to temporarily disconnect the cutting wire, e.g. when cutting holes in panels, so the connecting wires are soldered to solder tabs and are bolted, together with a few washers. The cutting wire is then simply sandwiched in between the washers and tightened up.

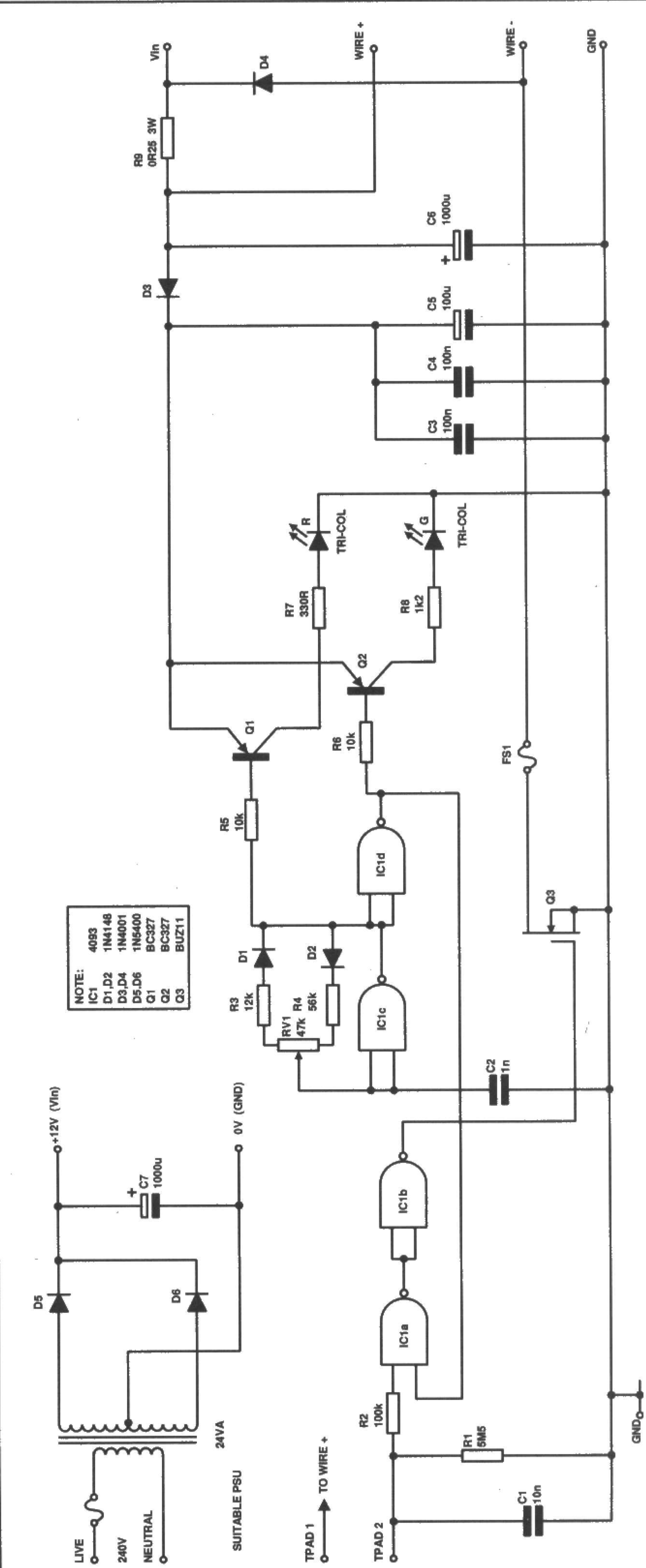


Fig.2 Circuit diagram

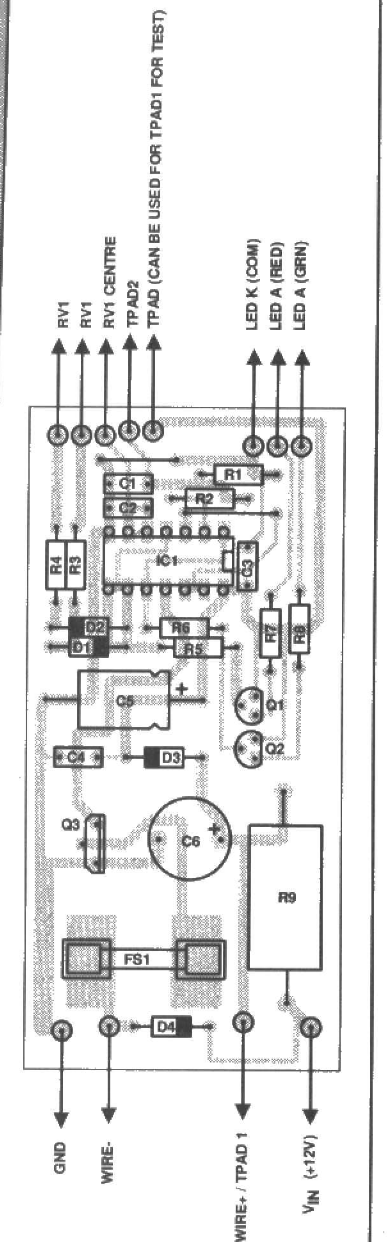


Fig.3 Component layout

This gives a simple, quick method of connecting and disconnecting the wire. A small spring is used to keep the cutting wire taught, but still allows some flexibility.

The touch strips on the handle can be any type of metal rod or strip. The two strips should be positioned apart, so that when the handle is held your hand covers both. The connecting wires should be connected as shown in Figure 3/4. Note that the WIRE+ wire connects to one touch strip and one end of the cutting wire.

Setting Up

The circuit should first be tested without the cutting wire. Connect the power supply to the circuit and connect a 12V bulb or an LED via a 1k resistor to the output terminals. With the touch pad connections open, turn the power on. The tricoloured LED should light and when the pot is altered, the colour should change from mainly green to mainly red. If it does not, check that D1 and D2 are the correct way round. Turn the pot until the LED goes green, then connect the touch pad wire to the positive supply (the test point can be used for this). The test LED or bulb should glow dimly, as the pot is altered the intensity should increase. If the bulb glows most brightly when the LED is green, swap the green/red connections to the tricoloured LED.

Assuming all is OK turn off, leaving the pot set with the LED at green and replace the test bulb with a piece of the Cutting Wire (the same length as to be used in the handle). Take care that the ends cannot be shorted out and that the wire is away from anything it may burn. When the power is applied to the circuit, the wire should warm up (this may not be visible at the cool setting) and as the pot is slowly altered, the wire should get hotter. When the other end stop of the pot is reached (the LED will be mainly red) the wire should be visibly glowing.

If the wire gets visibly hot before the end of the pot or does not get hot enough, a few adjustments will be required.

If the wire gets too hot at the maximum setting, increase the value of R4. If the wire does not get hot enough decrease R4. If the wire is too hot at the minimum setting, decrease R3 and if it's too cool increase R3. If the values of R3 and/or R4 are altered the tricoloured LED may appear too red or too green. The colour can be easily altered by changing R7 for the red content and R8 for the green (increasing the value decreases the intensity of the corresponding colour).

In Use

When using the cutting wire, you will find the wire will cool locally around the cutting point. To obtain the best results, the wire should be moved gently up and down as you cut, so that the local cooling has less of an effect. You may also find it helpful to build different sized handles, which can be swapped as required, to suit different situations.

PARTS LIST

RESISTORS

All 0.25W, 5% Carbon Film, except where stated

R1	5M6
R2	100k
R3	12k
R4	56k
R5,6	10k
R7	330R
R8	1k2
R9	0R25 (3W W/Wound)
RV1	47k Potentiometer

CAPACITORS

C1	10n
C2	1n
C3	100n
C4	100n polyester (5mm pitch)
C5	100µ/16V Elect
C6	1000µ/16V Elect

SEMICONDUCTORS

D1,2	1N4148
D3,4	1N4001
Q1,2	BC327
Q3	BUZ11 Power MOSFET
IC1	4093 CMOS Schmitt NAND Gate

MISCELLANEOUS

4A Slow Blow Fuse and PCB clips.
Tricoloured 5mm LED and clip.
Suitable 'cutting wire', approx. 3 ohms per 10cm, e.g. wire from the heating element from a hair dryer.
Extra-Flex wire to connect the handle to the control box.
Plugs and sockets, e.g. 'Wander' type
Suitable plastic box to house the circuit (e.g. 125 ∞60 ∞40)

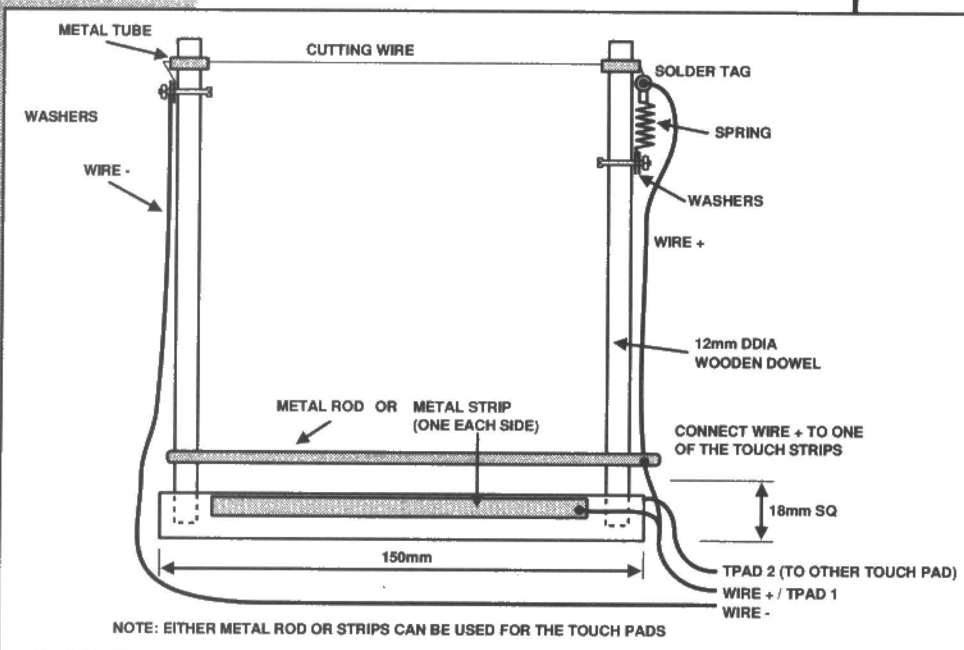


Fig.4 Cutting arm

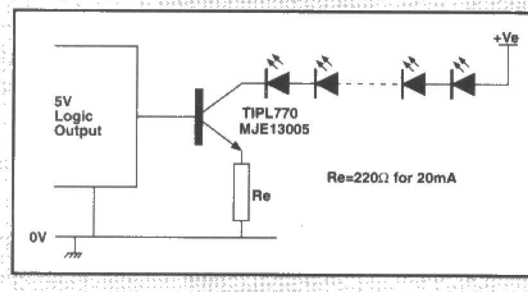
READ/WRITE ETI Letters

NOTE ADDED TO ETI AUGUST 1993 P.23

Supplies Supplies

I would like to congratulate you on one of the most interesting issues of ETI that I have read in a long time. It was nice to see the article on transformerless power supplies but hopefully your contributors will be able to design these safely in the future, and I won't have to write to complain. Contrary to what you seemed to infer from my letter, I have nothing against the transformerless power supply - I design circuits using them on a regular basis, but as I design them commercially, electrical safety is paramount and compliance to the relevant standards is mandatory.

Andrew Armstrong makes no mention of how to calculate R1 in Figure 4 (the surge limiting resistor). In practice, the larger the better. Not only does R1 limit the surge, it is the only limit to high frequency interference, where the capacitor reactance is negligible. I choose a 2W component for R1 and select its value such that $Iac^2R1 = 1W$ approx.. Class X capacitors are available up to 1µ, which gives a respectable current. If a 400V polyester is substituted it will blow up sooner rather than later, a 630V component will last a bit longer. D1 can be the Zener and D3 can be omitted to reduce component count giving an output voltage 0.6V less than the Zener voltage. The waveform at the junction of D1 and D2 is a very useful 50Hz square wave, but unfortunately it is in quadrature with the mains, not in phase.



I was very interested in Mr Binga's clock and I have used the circuit below instead of Figure 3 very successfully. For 5V logic, the current is 4.4V/Re and is independent of supply voltage fluctuations and number of LEDs in the chain. I have used +VE as rectified mains with next to no smoothing, but the transistor needs a heatsink. The TIPL770 or MJE13005 has a gain of at least 30, so the logic has to supply less than 660µA for 20mA in the LEDs.

If the clock has a 7-segment display, would fluorescent tubes be a possibility? Starting them would be interesting, I'll leave that design for someone else to do! Arranging to turn the heaters on a few seconds before voltage is applied to light the tube would be a possibility or, alternatively, running them cold-cathode from a leakage-reactance transformer.

On a final note regarding making PCBs, photocopying onto overhead projector film does not usually give enough density, but making two copies and fixing them together, one on top of the other usually produces excellent results, provided that the copier produces two copies of identical size.

Ian Benton
Ilkeston
Derbys

Andrew Armstrong replies: *For a low power design, R1 would be in the region of 0.6-1W. The minimum value of R1 with Vpk = 360V and I = 2.5A would be 144R (nearest preferred value of 150R). If 50mA is drawn, you would need a 10W version of R1 (150R).*

Power Down Problem

I am currently attempting to design a circuit incorporating CMOS Static RAM and I would be very grateful if you could offer some advice.

The circuit is designed to download and store data from a computer's serial port using two CMOS Static RAMs, (6264 8K x 8bit and 62256 32K x 8bit). Both devices share a common address bus in my circuit design, but are individually selected to store data by switching logic. It is vital that data is retained after switching off the main 5V supply to the circuit.

It is simple enough to connect a battery backup to the RAMs using diodes to maintain power to the chips when the main 5V supply is switched off. One possible problem, however, is the fact that the logic circuitry controlling the RAM chips may set the READ, WRITE and CHIP SELECT lines to an undesirable state as they power-down. The effects of this would be possible corruption of data in one or more RAM chips.

It seems that a voltage monitoring circuit is required to disable writing to both RAM chips during switching on and switching off the main 5V supply. The CHIP SELECT lines of both RAMs must be available for use by the rest of the circuit when the main 5V supply is present.

Any suggestions for such a circuit would be gratefully received and I'm sure would interest other readers.

G A Haddon
Birmingham

Your request is being dealt with and will appear as a Blueprint. - Ed.

InterCard 1 Update News

Here's an update on developments concerning the InterCard 1 Universal Interface Card for the IBM PC:

1) The software disk for the project has been revised to version 1.1. Improvements to the disk are mainly to do with the format and structure of the files, with a few extra sound samples. No new programs yet.

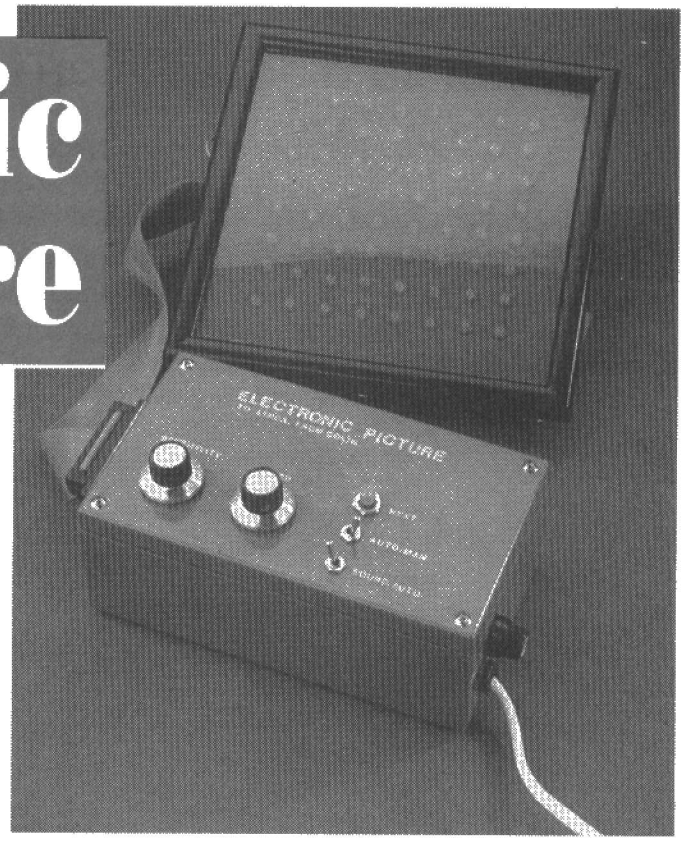
2) Distribution of the software disk is now being handled by:

The Public Domain
Software Library
Winscombe House
Beacon Roall
Crowborough
Sussex
TN6 1UL
United Kingdom
Tel: (0892) 663298

The volume number of the InterCard 1 software is 3861 - this should be quoted when placing an order. The current cost for one disk in the UK is £6-00, with free postage. Due to other commitments I will no longer be able to honour requests for the software disk. All future orders should be sent to the PDSL at the above address. Those readers who originally acquired the high-density version of the disk from the author and found two extra directories of programs - namely SCOPTRAX and MODPLAY - should note that the disk from the PDSL does not contain these programs (they can be found on disks 3676 and 3554 respectively) Further details/catalogue available from the above address.

Neil Johnson

Electronic Picture



A moving LED display by Colin Meikle

I designed this project as a novel present for my girlfriend. I intended building some sort of display that could show a series of short messages and the original intention was to build a large display that would show several words at a time, although I soon discarded this idea. The circuit would be too complex and even the size of the display would be impractical for my girlfriend's bedroom. I therefore decided on a small LED display that would display one character at a time. This had several advantages, the display could be built into a small picture frame and the electronics to drive the display could be kept very simple. I soon realised that in addition to text, interesting patterns could be displayed. As development progressed, I thought the patterns would be more interesting if they responded to surrounding sound, particularly music, so a sound activated circuit was included.

The Electronic Picture itself is made up of an 8 ∞ 8 array of LEDs, mounted in a small picture frame. The picture can display short text messages, or various types of patterns to form visual effects. It is similar to the LED type displays found in Post Offices and shops, but on a smaller scale. The circuit allows the messages or patterns to be displayed at a fixed rate. In addition, the circuit has a built in microphone, which allows the display to respond to surrounding sounds. This feature is of little use for text messages but very good visual effects can be created. Both modes of operation have controls that allow the sensitivity or speed to be altered. A switch allows either sound or automatic mode to be selected. The circuit can store 16 different sequences, which can be individually selected (a push button allows you to cycle through the sequences), or all the sequences can be displayed in turn after a set number of repetitions.

The patterns or messages are stored in an EPROM. Programming the EPROM is a time consuming task (although not as difficult as you may first think), but this is a compromise to keep the circuit simple. The circuit can be powered from the mains or via a small external PSU.

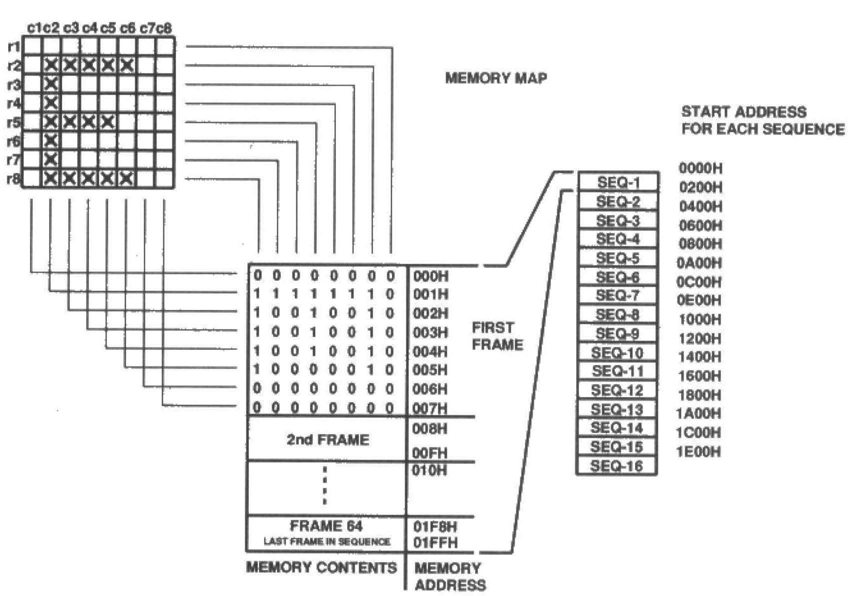
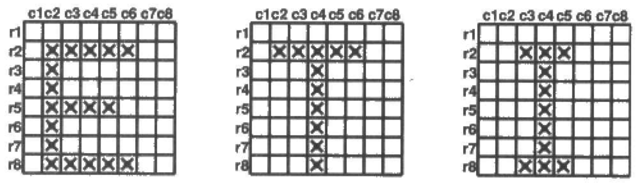


Fig.1 Memory Map

PROJECT

STEP 1:
DRAW PATTERN
ON GRID



STEP 2:
CONVERT OFF LEDs
TO ZEROs AND ONEs

0	0	0	0	0	0	0	0
0	1	1	1	1	1	0	0
0	1	0	0	0	0	0	0
0	1	0	0	0	0	0	0
0	1	1	1	1	0	0	0
0	1	0	0	0	0	0	0
0	1	0	0	0	0	0	0
0	1	1	1	1	1	0	0

REPEAT FOR ALL FRAMES IN SEQUENCE

STEP 3:
CONVERT TO HEX

00H FEH 92H 92H 92H 82H 00H 00H

00H 02H 02H FEH 02H 02H 00H 00H

00H 00H 82H FEH 82H 00H 00H 00H

EXAMPLE 1A: DATA FOR THE CHARACTERS 'ETI'

0000	00	00	00	00	00	00	00	00
0008	00	00	00	00	00	00	00	00
0010	00	00	00	00	00	00	00	FE
0018	00	00	00	00	00	00	FE	10
0020	00	00	00	00	00	FE	10	10
0028	00	00	00	00	FE	10	10	10
0030	00	00	00	FE	10	10	10	FE
0038	00	00	FE	10	10	10	FE	00
0040	00	FE	10	10	10	FE	00	00
0048	FE	10	10	10	FE	00	00	82
0050	10	10	10	FE	00	00	82	FE
0058	10	10	FE	00	00	82	FE	82
0060	10	FE	00	00	82	FE	82	00
0068	FE	00	00	82	FE	82	00	00
0070	00	00	82	FE	82	00	00	00

FIRST '15 FRAMES OF
A SEQUENCE

EXAMPLE 1B: EXAMPLE OF SCROLLING TEXT

THIS EXAMPLE SCROLLS 'HI' ACROSS THE DISPLAY
NOTE THAT IT TAKES 15 FRAMES TO SCROLL TWO LETTERS

0000	10	10	10	10	10	10	10	00
0008	02	04	08	10	20	40	80	00
0010	00	00	00	FE	00	00	00	00
0018	80	40	20	10	08	04	02	00

EXAMPLE 1C: 'SPINNING ✳ ' PATTERN

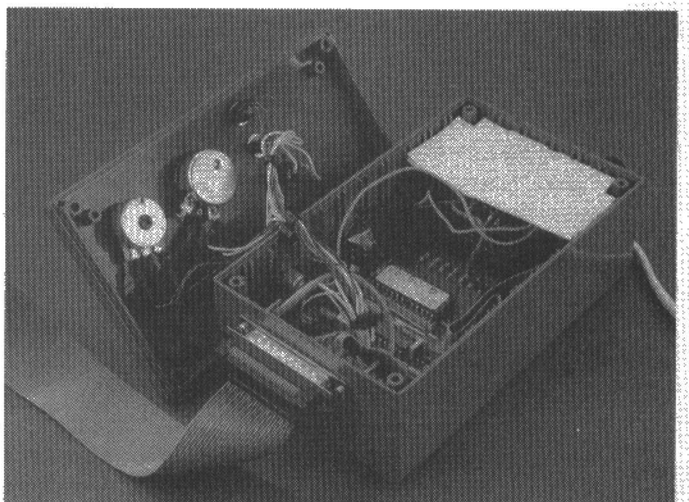
THIS SEQUENCE STARTS WITH A '—', FOLLOWED BY '\',' | ',' /'
THIS GIVES THE EFFECT OF A SPINNING STAR
(THE STAR SPINS IN TIME WITH THE MUSIC'

Fig.2 Examples for creating patterns

In Operation

It is important to understand the memory organisation and the way in which patterns are displayed if you are to create your own display sequences. Figure 1 shows how the memory is organised and how it relates to the LED display.

The EPROM is an 8K ∞ 8bits device. Each byte in the EPROM corresponds to a column on the LED display. Each of the 8 bits within the byte control a LED within that column (setting a bit to a 1 turns the LED on). The memory is firstly organised into 8 byte blocks and each block corresponds to one complete picture 'frame' (one byte for each of the 8 columns). By repeatedly displaying the 8 byte block, with each column displayed in quick succession, it appears that all 8 columns are being displayed at the same time, although there is only one on at any one time. Referring to Figure 1, memory location 0000 corresponds to the first column C1, the data in this location is 00H, thus all the LEDs on this column would be off. Location 0001 corresponds to the second column C2, this contains FEH, where all the LEDs in column C2, apart from the top LED R1, would be on. If you complete this for the complete block (i.e. 0000 to 0008) you will find the character 'E' would be displayed. Each of these 8 byte blocks are displayed for a period of time, e.g. 1 second,



then the next 8 byte block is displayed. This next block would contain, the next character in the message or the next part of the picture sequence. Thus, each 8 byte block defines a picture frame. 64 of these blocks are displayed in sequence for a set period of time, to create a complete message or

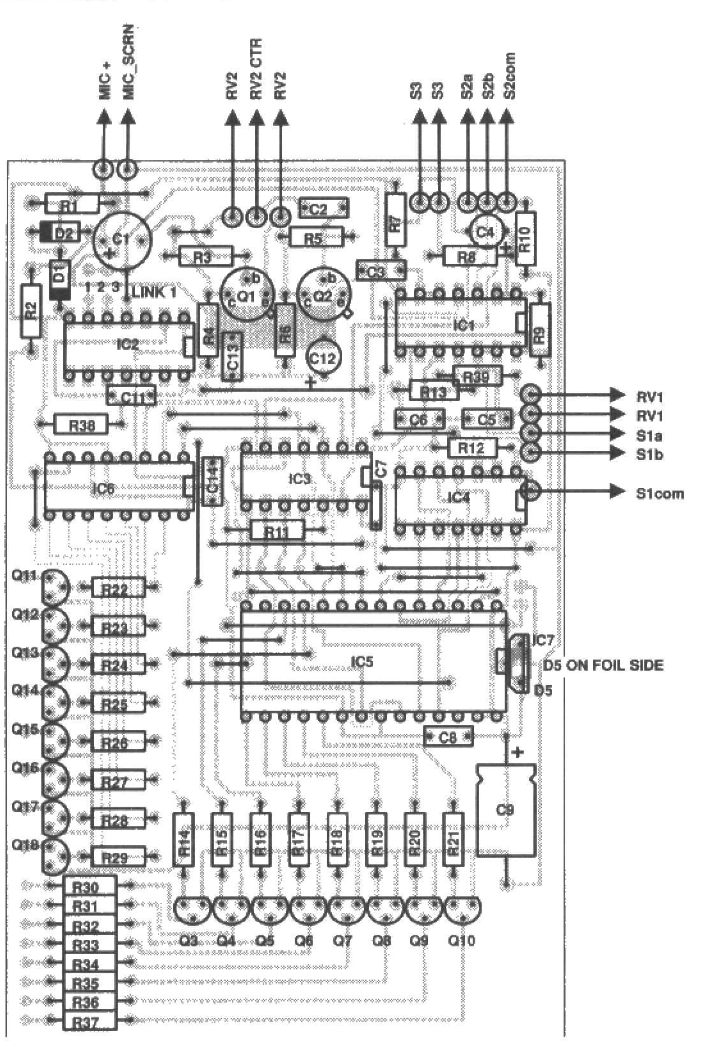


Fig.3 Component Overlay

effect. Since there are 64 frames in any complete message or effect, the maximum length of a message is 64 characters. At the end of each message or effect, the circuit loops back to the first frame in the sequence and the sequence is repeated. If the period between each frame is shortened, the individual frames can be run together to create moving pictures or scrolling text.

If the circuit is operating in sound mode, the period between frames depends upon the music or surrounding sounds, (as a result text is difficult to read in this mode, but it results in interesting patterns). The total memory used for one complete message or picture sequence is 0.5K, therefore 16 individual messages or sequences can be stored in 8K of memory (8 columns ∞64 frames ∞ 16 sequences = 8K of memory).

Creating Patterns In The EPROM

Messages can be displayed in a number of different ways. The most memory efficient way is to display one character at a time (note only one full character can fit in the 8 ∞ 8 array of LEDs). This method makes long messages difficult to read. A better way is to scroll characters across the display, although this uses a greater amount of memory and the length of the message that can be displayed is greatly reduced. You may find the 64 frames is a limitation when creating messages but this can be expanded if required (see the section on further expansion). When creating patterns or visual effects, the 64 frames will be more than adequate. To create your own patterns you first must have access to an EPROM programmer and you will find a good text editor invaluable.

The first step is to draw out an 8 ∞ 8 grid on a blank piece of paper, to represent the display. Number the columns (C1-8) and rows (R7-0), see Figure 2 This can now be used as a template. Place a thin piece of blank paper on top of your template and lightly draw on the grid, the character or pattern you wish to display. Put a X in all the boxes where a LED should be On. Note that if only displaying text, a 5 ∞ 7 array should be marked out (as most text can fit into this array), that is, don't use C1, C7, C8 and row R1.

The next step is to convert the Xs into a Hexadecimal number. This can be done in two steps, convert the Xs to 1s and the blank spaces to 0s (remember to include all the blank columns). Reading each of the columns, convert the 8 digit binary number into a hex number (note the bottom, R7 is the MSB). This can be seen in Figure 2, example 1. This process is simply repeated for all the different picture frames you require for your sequence. Remember, you need 64 frames to complete one sequence. If your sequence is, say only 16 frames it can simply be repeated 4 times to fill the 64 frames, blank frames (i.e. all 0s) or repetitions of frames can be used to pad sequences out.

Displaying moving (i.e. scrolling) text, is equally simple. For example, to scroll the letter 'E' across the display. Draw the 'E' on the grid, as previously described, move the top sheet of paper so that the 'E' is just to the right of the grid, so that the grid is blank. The blank grid is the first frame.

Move the top sheet one box width to the left, the first part of the 'E' should now be on the grid, (i.e. a vertical line in C8 from R7 through R1) - this is the second frame. This is simply repeated until the 'E' is shifted fully into the display, the next character can be shifted in from the right as the 'E' is shifted out to the left.

Although this may seem a very long process, after a bit of practice it becomes very easy, and drawing each pattern be comes unnecessary.

A small problem will arise when displaying individual characters and moving text or patterns. To display individual characters, you require the frames be displayed at a much slower rate than for moving sequences (e.g. Characters have to be displayed for >1 second, but moving sequences require frames to be displayed for <0.25 sec). This can be overcome by setting the frame speed to the faster setting (e.g. 0.25s). When individual characters are to be displayed they can be repeated a number of times, so in effect they are displayed for a long enough period of time. This avoids having to alter the frame speed between sequences.

Figure 2 gives a few more examples for frames and sequences. When you have collected all the data for your picture sequences you must generate a valid fuse map. Figure 1 shows the start and end addresses for each sequence. If you wish to generate your fuse map in INTEL HEX format, which is accepted by most EPROM programmers, the format is given below.

:Byte Count|Address|Block Type|Data Bytes|Checksum
Byte Count : No. of data of bytes E.G 08 (2 Characters)
Address : 4 ASCII hex characters E.G. 0008
Block Type: 2 characters. 00 data, 01 end of file
Data Bytes : Data, No. of bytes specified by byte count
Checksum : Two's Complement of the sum of all the bytes in the line.

e.g. :0800000000FE929292820000FDC2 'E'
:08000800000202FE02020000FFEA 'T'
:08001000000082FE82000000FFE6 'I'
:00000001FF END OF FILE
(last line, always the same)

Note: Ensure there are no extra characters after the checksum.

Construction

Construction of the PCB is fairly straight forward and Figure 3 shows the component overlay. The main thing to be careful about is the placement of the numerous links. These must be put in place first, as some of them go under IC5. Also make sure that all the links are insulated, as some are close together. Next, solder in place all the resistors and diodes, followed by the ICs and transistors. All the ICs can be mounted in sockets if desired, but IC5 (the EPROM) must be, as it will probably need to be removed several times. The regulator, IC7, requires mounting on a small heatsink, which can be directly mounted to the regulator with some heatsink compound. If the heatsink is close to any of the component leads, use an insulator and mounting kit to isolate it. Do not mount the regulator too close to the board or the heatsink will foul against IC5 (if it does, bend back or cut off the bottom fin of the heatsink). D5 is soldered on the reverse of the PCB across the regulator's input and output terminals.

Figure 4 shows connections to the switches and potentiometers. When connecting the microphone, check the connections with the microphone you have bought. The PSU components, i.e. transformer, C10 D3 and D4, are not mounted on the PCB and all connections to these should be suitably sleeved. Take care that all the usual mains precautions are observed when mounting the components in it's enclosure. Alternatively, the circuit can be powered from an external 9V DC supply that can supply greater than 300mA. Simply connect the supply to the +ve and 0V inputs on the PCB. This method may be preferred if the circuit is to be operated by children - it removes the mains hazard and reduces the size of the control box.

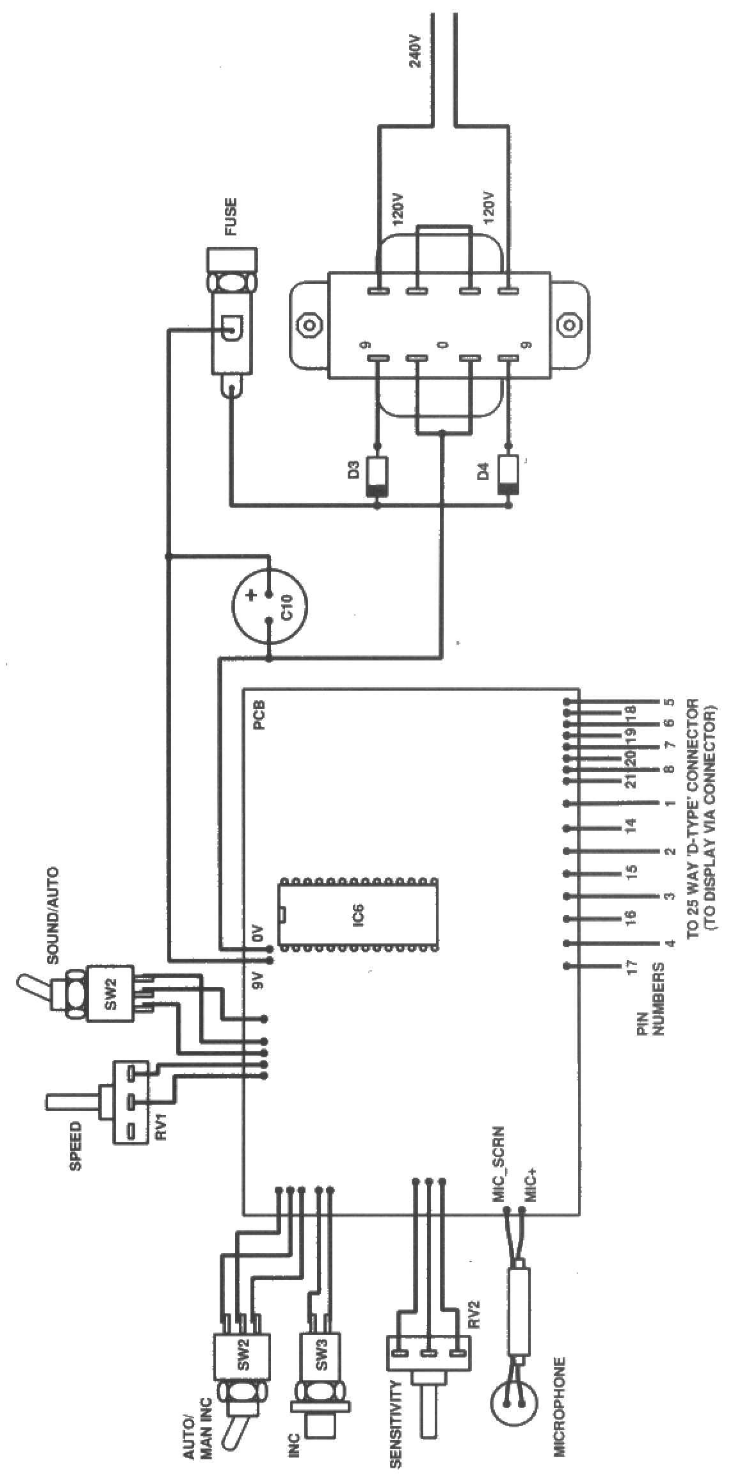


Fig.4 Interconnections

Figure 4 also shows the connections to a 25 way D Type connector. Obviously any pins on the connector can be used as long as the rows and columns match up on the control box and on the display. You may even wish to omit the connector and take a ribbon cable directly to the display, although the connector is recommended.

Display

The 64 LEDs are mounted on a thick piece of black card, within a small picture frame as shown in Figure 5. Any picture framing shop will make the frame for you. A plastic face will give more room for the LEDs than would glass. The card should be cut to size, to fit the frame and then the

NOTE:	
IC1	4093
IC2	4024
IC3	74HC393
IC4	4024
IC5	27C64-15
IC6	74HC138
IC7	7805
Q1,2	BC109C
Q3-Q10	2N3706
Q11-Q18	BC327
D1,2	1N4148
D3-D5	1N4002
LED1-LED64	5mm DIFFUSED RED LEDs
FS1	1A 125V FUSE

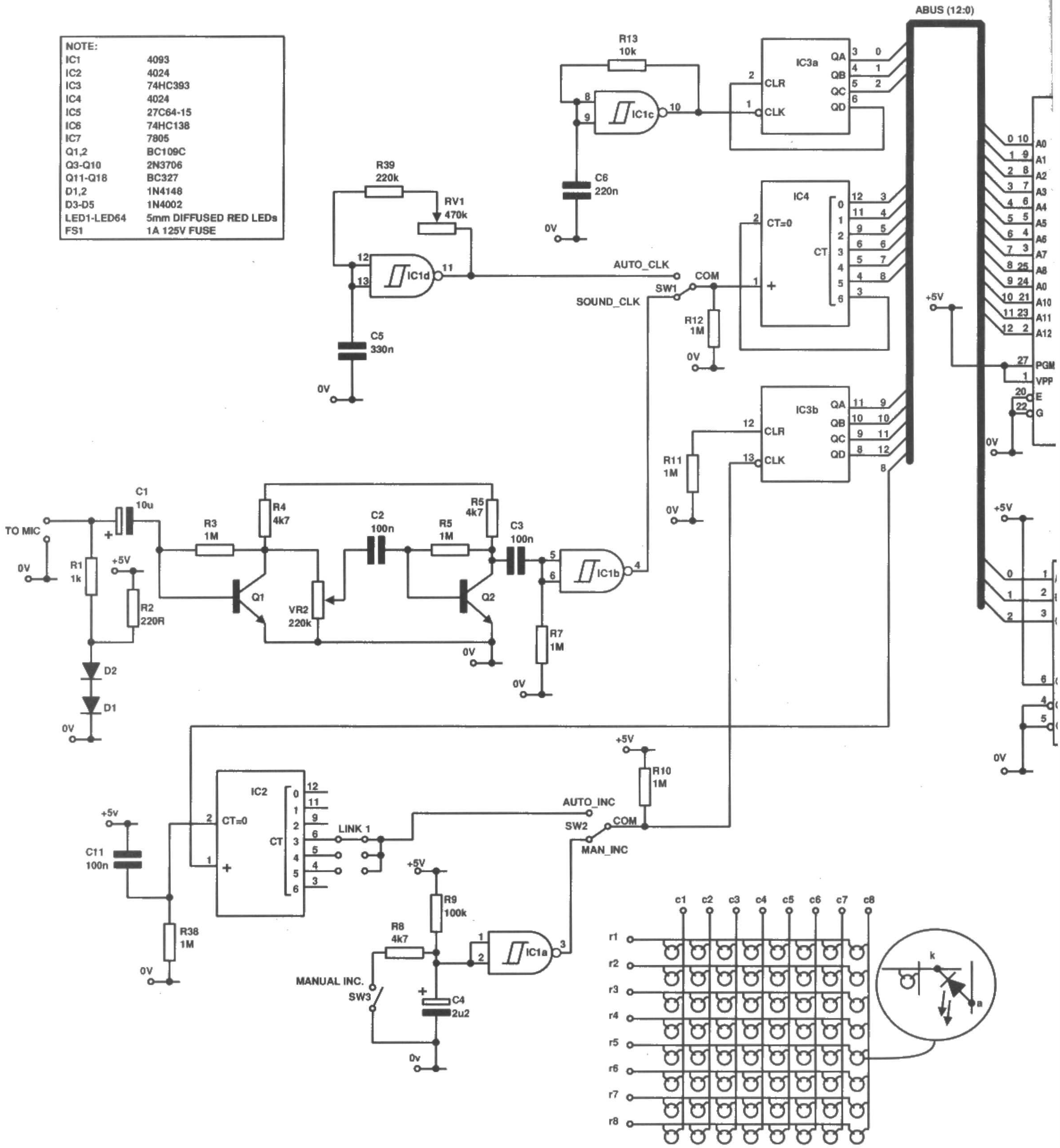
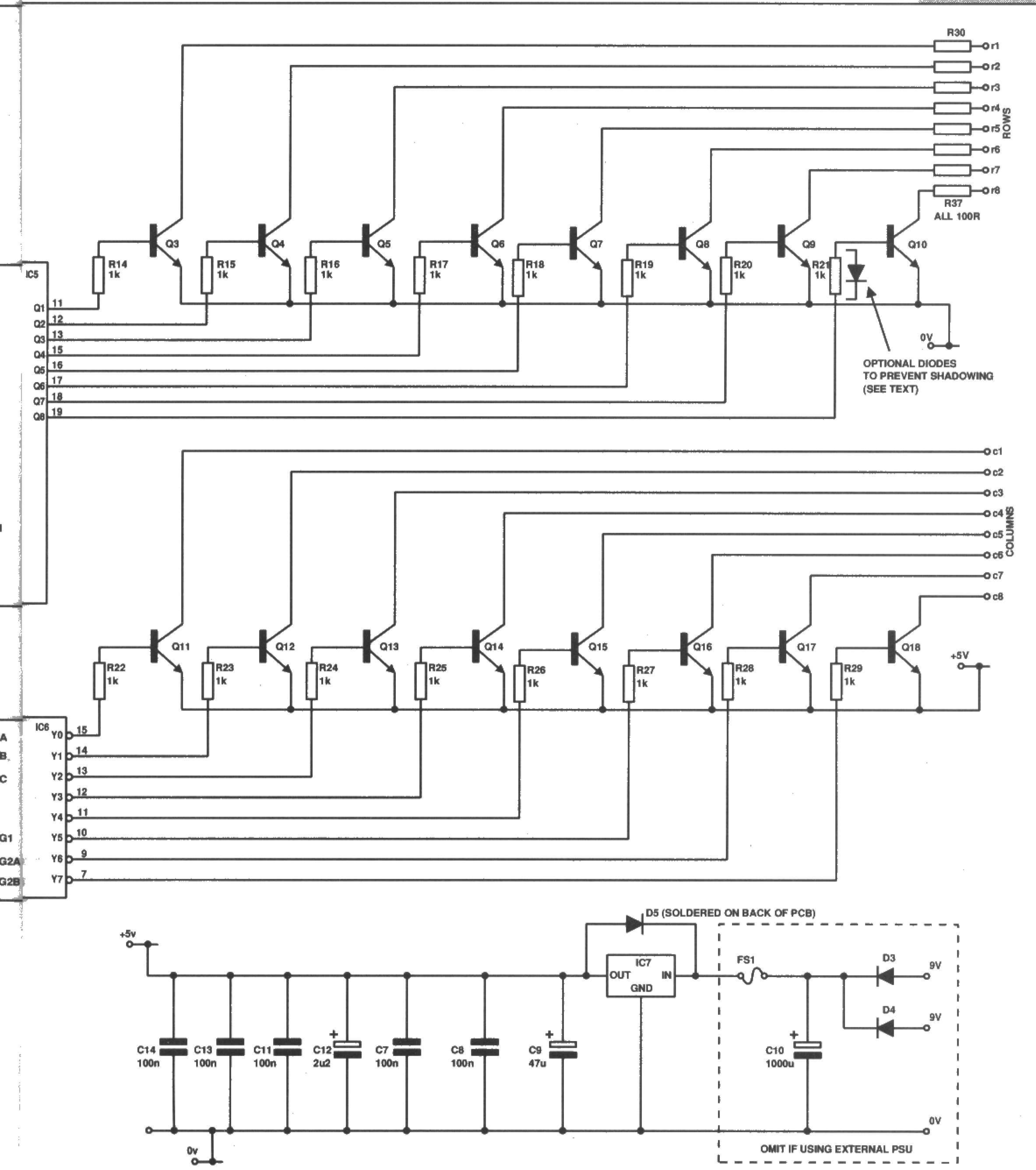


Fig.6 Circuit diagram


R30
r1
r2
r3
r4
r5
ROWS
r6
r7
r8
R37
ALL 100R
IC5
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
Q3
Q4
Q5
Q6
Q7
Q8
Q9
Q10
R14 1k
R15 1k
R16 1k
R17 1k
R18 1k
R19 1k
R20 1k
R21 1k
0V
OPTIONAL DIODES
TO PREVENT SHADOWING
(SEE TEXT)
c1
c2
c3
c4
c5
COLUMNS
c6
c7
c8
Q11
Q12
Q13
Q14
Q15
Q16
Q17
Q18
R22 1k
R23 1k
R24 1k
R25 1k
R26 1k
R27 1k
R28 1k
R29 1k
+5V
IC6
A
B
C
G1
G2A
G2B
Y0
Y1
Y2
Y3
Y4
Y5
Y6
Y7
D5 (SOLDERED ON BACK OF PCB)
+5v
IC7
OUT
IN
GND
FS1
D3
9V
D4
9V
C14 100n
C13 100n
C11 100n
C12 2u2
C7 100n
C8 100n
C9 47u
C10 1000u
0v
0V
OMIT IF USING EXTERNAL PSU

HOW IT WORKS

Refer to the circuit diagram. Operation of the circuit is quite straight forward. The display is simply an 8 ∞8 array of LEDs, the anodes in each column and the cathodes in each row are commoned together. An 8k EPROM, IC5, contains all the display information, which is output to the display under the control of the other circuitry (the memory organisation is explained in the Principles of Operation).

The address of the EPROM and hence the display data, is generated by 3 counters. IC3a is configured to count from 0 to 8 which generates A0-A2. It is this counter which generates each individual picture frame. IC6 decodes the output from this counter to select the correct column of the display for any particular address. The counter is clocked by a simple oscillator generated by IC3. Note that the frequency of this oscillator has been selected to be fast enough to prevent the LEDs flickering, but slow enough to limit shadowing.

IC4 counts from 0 to 64 to select each of the 64 frames in turn. This counter is clocked from one of two sources. The first is the 'auto_clk', which is an oscillator generated by IC1d. Its frequency is altered by RV1 allowing the speed of the sequence to be altered. The other source is the 'sound_clk'. Here, the signal from a small microphone is amplified by Q1, Q2 and associated circuitry. The resultant signal is fed into IC1b, to generate better defined pulses which are fed into the counter. The counter will therefore respond to the surrounding sound.

IC3b generates the last 4 address bits, A9-12, which determine which of the 16 sequences is selected. This counter, can be clocked from one of two sources. Firstly from a manual switch, SW3. IC1a, C4, R8 & R9 form a simple debounce circuit so that one pulse is generated each time the switch is pressed (this works because IC1 has Schmitt inputs). Alternatively, the sequences can be incremented automatically. A8 toggles once every sequence, this is used to clock IC2 which effectively divides this down by 16, 32 or 64 dependent upon the position of link_1, hence each sequence is displayed 16, 32 or 64 before advancing to the next one.

The output transistors provide the necessary drive to power the display. The LEDs are actually driven at a higher level than normal (30mA), which is acceptable because they are on a 12% duty cycle.

positions of the holes marked out on the rear of the card. Next, carefully drill the 64 holes (diameter to suit the clips that are used). When all the holes have been drilled, any ragged card round the holes can be tidied up with a scalpel or sharp knife. The LEDs and clips can then be put in place on the drilled card - remember to align all the anodes and cathodes, as shown in Figure 5 (note the cathode is normally identified by the flat on the side of the body).

When all the LEDs are in place and correctly lined up they can be connected as shown. All the cathodes in each row are connected together and all the anodes in each column are similarly, connected together. Take care that neither the rows nor columns can be shorted together. Also, take care not to weaken or break any LED legs, if you have to bend any.

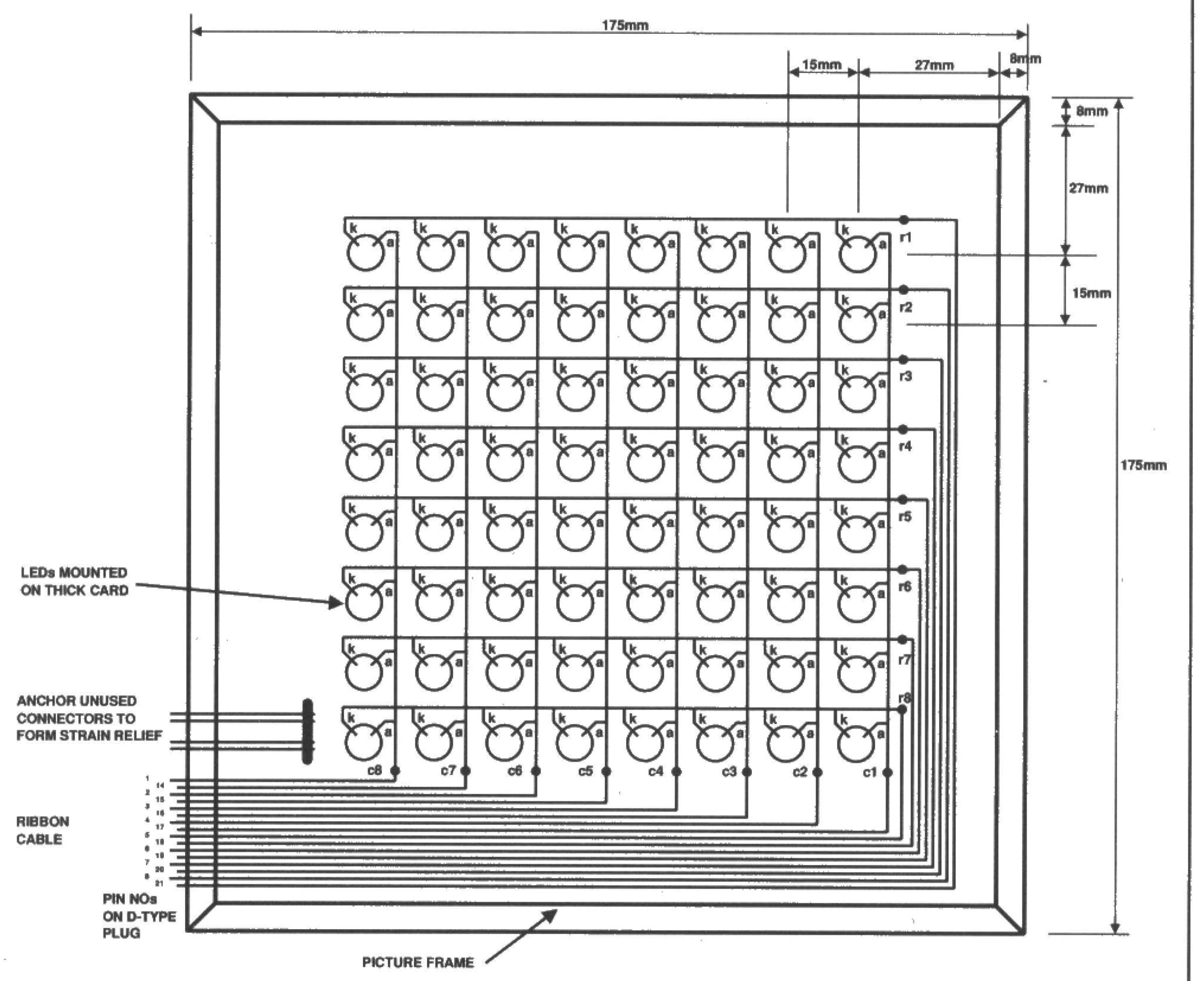


Fig.5 Construction of Display

When the circuit has been tested and found to be correctly working, the back of the 'picture' can be coated in silicon rubber (the clear type used to seal sinks, windows, etc. works well). This will help to hold all the LEDs in place and will also stop accidental shorts.

Note that the LEDs used should all be of the same type. The best way to get LEDs of matched brightness and colour, is to buy all the LEDs from the same supplier at the same time. Beware of bargain packs as they may contain different types. It is also best to use bright diffused LEDs with a wide viewing angle.

The suggested connector is a 25 way D Type. Using an IDC type simplifies the connections required. Although only 16 conductors of the ribbon cable are needed, the other 9 conductors can be glued to the back of the picture to prevent straining the other wires.

Testing

Before testing can start there is one option which should be set. The position of LINK_1 determines the number of times each sequence will repeat when in auto increment mode. In position 1, each sequence will repeat 16 times, in position 2, 32 times and 64 times in position 3. The link should be soldered in whichever position you wish (initially, for testing, it does not matter).

To test the circuit, connect the PCB up to an external 9V PSU (so you can poke about without worrying about the mains voltages). With a programmed EPROM in place and the display connected, turn the power on. Hopefully something will appear on the display, with SW2 in the manual position. Press SW3 a few times to advance the sequences (if you have not filled your EPROM this may be necessary, until you find a valid sequence). Assuming you have something on the display, with SW1 in the AUTO position, a valid sequence of pictures should be displayed. Altering RV1 should change the speed at which they are displayed. With SW1 in the sound position, any sound close to the microphone should alter the display. RV2 should alter the sensitivity. If everything appears to be OK, the internal supply can be connected (if used) and the circuit can be put into it's box and suitably secured.

If everything is not OK, there are a few things to check. First check for the obvious - solder shorts, missing links, correct component orientation. If parts of the display do not appear to be working check the orientation of the LEDs. If the pattern on the display does not make sense, check the row and column wires have been connected correctly and ensure you have a valid EPROM. If the sound circuitry does not work check the connections to the mic. are correct.

A small amount of shadowing on the display may be seen under certain circumstances. This was not found to be a great problem on the prototype, but if you wish, there is a simple solution. The problem is caused because the output transistors cannot turn off quickly enough (Q3-10 seem to be the main culprits). A small diode (1N4148) should be soldered across the base resistors (R14- 21), the anode towards the transistors and cathode (stripe) towards IC5. This will cause the transistors to be turned off much more quickly.

You may wish to alter the frame speed, i.e. the time between successive frames, although RV1 gives a large amount of control. This can be done by altering C5 - increasing it's value will slow the frame speed.

PARTS LIST

RESISTORS

R1, 14-29	1k
R2	220R
R3,5,7,10	1M
R11,12,38	1M
R4,6,8	4k7
R9	100k
R13	10k
R30-37	100R
R39	220k
RV1	470k
RV2	220k

CAPACITORS

C1	10µ/16V elect
C2,3	100n ceramic
C4,12	2µ2 tant
C5	330n min. poly
C6	220n min. poly
C7,8,11,13,14	100n miniature poly or ceramic
C9	47µ/16V elect
C10	1000µ/16V elect

SEMICONDUCTORS

IC1	4093
IC2	4024
IC3	74HC393
IC4	4024
IC5	27C64-15 8K ∞8 CMOS EPROM
IC6	74HC138
Q1,2	BC109C
Q3-10	2N3706
Q11-18	BC327
D1,2	1N4148
D3,4,5	1N4002
IC7	7805 5V 1A
LED1-64	5mm Red LEDs (high intensity preferred)

MISCELLANEOUS

2 terminal miniature electret mic
2 x miniature SPDT toggle switches
Miniature push switch
TR1 Transformer 6VA 0-9, 0-9V o/p.
(or 9V external PSU >300mA o/p).
1A fuse and panel mount fuse holder
25 WAY D type socket
25 WAY D type plug (IDE Type)
64 Low profile LED clips
Small TO220 heatsink (21°C/W)
Box (150 x 90 x 60mm Approx.)

Further Expansion

If you wish to experiment, the amount of memory could easily be expanded. A 16K EPROM could be used in place of the 8K, the additional address line A13 would come out on pin 26. If the track between IC4 pin 2 & 3 is cut and pin 3 connected to the additional address line, the length of each sequence could be doubled, although the last 64 frames of each sequence would be offset by 8K (i.e. the first 64 frames of seq 0 would be at 0000 to 01FF and the last 64 would go from 2000H to 2FFF). Alternatively, the number of sequences could be doubled by connecting A13 to the common pin of a SPDT switch with the other two pins connected to 0V and +5V. The switch would allow the upper or lower 16 sequences to be selected.

There are also 4 unused pads on the PCB. These are connected from A9 to A12. This allows the current sequence number to be decoded and displayed on a 7 segment display (with a little decoding). None of the above suggestions have, however, been tested.

Anniversary AutoMate Mixer

This month, Mike Meechan looks at Pots and Pans and just what they have to do with Routing

It is a belief widely held by engineers and designers alike that on a desk, there can never be too few Aux Mixes (or FX Sends, or a Foldback Mixes as they are sometimes known). Some might go so far as to say that the number (or lack) of facilities in this particular region determines just how flexible (or inflexible, as the case may be) the whole of the desk is.

The Aux Mix section is an area of the desk which lends itself readily to some form of AutoMation. The requirement for automation has arisen because of the pressing need, in the interests of space, convenience, and more importantly, economy, to share FX units between tracks. The engineer may mixdown each vocal track separately and during each of these operations, he may wish to add reverb, so the reverb unit might be connected to Aux Mix 1 output socket. Any channel requiring access to the reverb during mixdown would have its signal routed to the mix bus via the associated Aux Mix 1 Level pot - and perhaps an Aux Mix 1 Mute/ Unmute pushbutton - at the appropriate time. Perhaps, once a collage of almost-completed sounds had been built up, the FX might only be required for brief intervals, or perhaps on different channels in quick succession. Such an operation lends itself readily to implementation by the console automation system, which itself may be under the direction of some kind of automatic time reference control (timecode), or manual time reference.

On a fully equipped Aux Mix module, there are a total of 12 accessible buses. Aux.'s 1 - 4 are switchable Pre or Post Fade. These are also stereo FX sends, with each Aux Mix able to be panned across the pair of busses associated with the control. In effect, a stereo signal fed to an external FX unit can have the same spatial positioning as the channel, or a different one, for special effects. Within this particular group of Aux Mixes, number 1 is the most capable of the four. Not only is it able to be switched pre or post fader, but the output from the panpot is able to be routed not to Aux 1 Mix bus, but rather to the multitrack group routing matrix. The normal source assigned to the Group Routing Matrix (the Channel panpot) is disconnected in this instance, although routing to the main stereo mix busses is uninterrupted and available, as always, via the Mix pushbutton. In effect, this means access to a further possible 32 busses, with all of the attendant operational advantages, especially during those occasions where a lot of different foldback or monitor mixes are required (PA work, perhaps).

Aux.'s 5-8 are post fade stereo pairs, able to access the 5/6 pair, or the 7/8 pair, or another pair - 9/10 in the instance of 5/6, and 11/12 in the instance of 7/8. Each of the six pairs of Aux Mixes on the AutoMate channel architecture can be muted or unmuted by the console AutoMation system (if this is fitted). AutoMated control can be overridden manually with local, strip-mounted pushbuttons. Even on a non-automated console, it is still possible to properly mute any of the twelve Aux Mixes as a pair.

Although proper muting and turning the rotary level control to zero would seem to be doing the same thing (.i.e. reducing the channel's contribution to that Aux Mix bus to zero), they are completely different in their electrical operation and subsequent effect. Muting in the correct sense of the word means physically disconnecting the bus driving resistor from the mix bus, whereas moving the level control to zero merely attenuates the channel contribution.

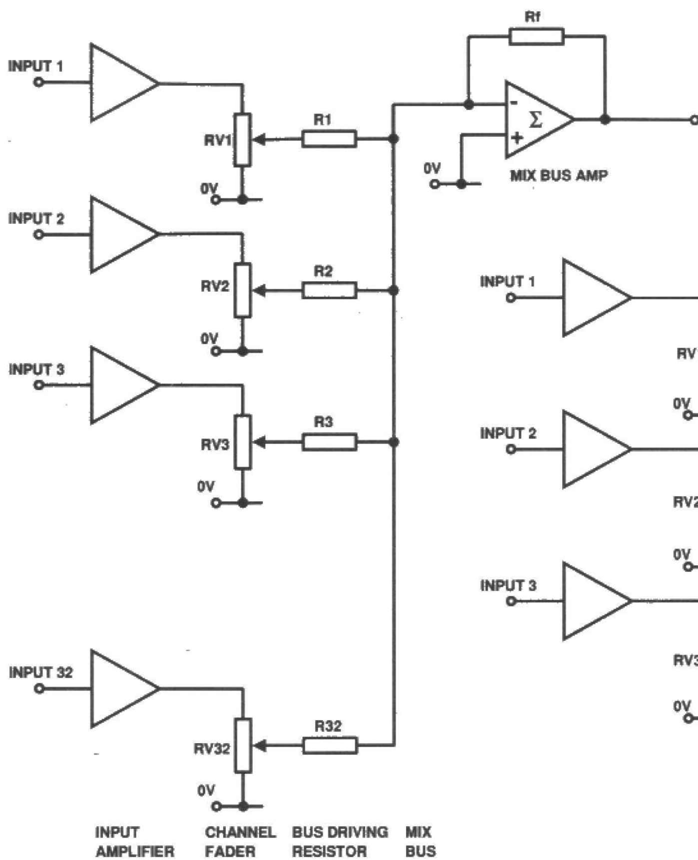
Ah, you may say, but surely this has the same subjective effect, in that each method removes the unwanted signal (associated with that channel) from the bus. This is partially true, but it misses the point of most importance, and unfortunately, it is a common misconception shared by engineers and designers alike. Insofar as the channel signal is concerned, both are similar, but with the mix bus, the two most definitely do not achieve the same effect.

To understand the basic electrical differences between muting and attenuation, we need to refer to something said way back in the past (Part 4). Consider Figure 1a. On the face of it, the first two achieve the same electrical effect - isolation of signal input from mix bus -with Figure 1b scoring in the added convenience stakes by providing the facility - a switch - to turn the signal send on and off from the mix bus at any desired level. Many mixers use this technique in so-called muting circuits, so what is wrong with it?

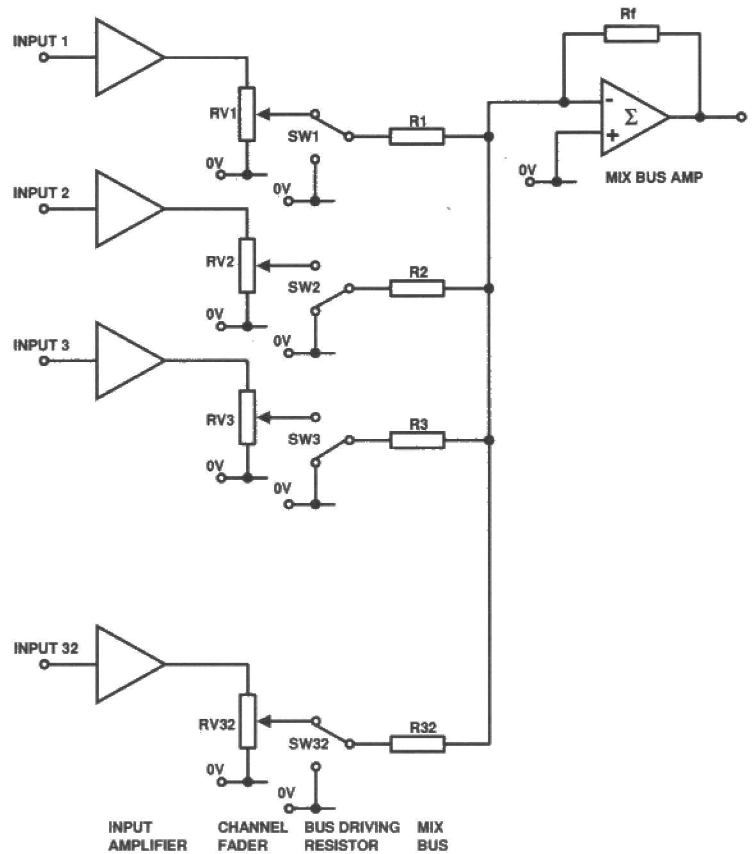
Consider Figure 1a once more, since it is a not untypical arrangement, with 36 or so channel inputs all able to contribute to a particular Aux Mix bus (which we'll call Aux 1, for arguments sake). We've also just recently bought two thousand quids worth of all singin', all dancin' digital FX gizmo which, quite naturally, we want to use on many parts of the final mix. We connect its input to FX Send 1 (Aux 1 Output), connect its output to the FX Return, turn Channel 1 Aux Mix 1 Level control up and start the tape machine, with Track 1 replaying through Channel 1 - it's an in-line desk. The vocal ends and we suddenly think, "Wait a minute, where's that hiss coming from." We check the FX manufacturer's spec. sheet which quotes noise and distortion as being -90 down on 0dBu. We know from experience that the hiss isn't -90dBu - more like -60dBu. We mute (or turn down) Aux Mix 1 on all of the channels and the hiss is still there, so it can't be coming from the channels. Hey presto, unplugging the FX unit from the FX Return socket causes the noise to disappear. QED. Must be a noisy FX unit, or a manufacturer quoting some distinctly unrealistic figures in the spec. sheets - adman's euphemism for lying - or both? Not necessarily...

Pause to consider the mix bus at this time. We have 36 paralleled Rs's and one Rf. All resistors are equal in value, so it's unity gain for each of the individual contributions to the mix bus, and a gain of 36 for any composite signals

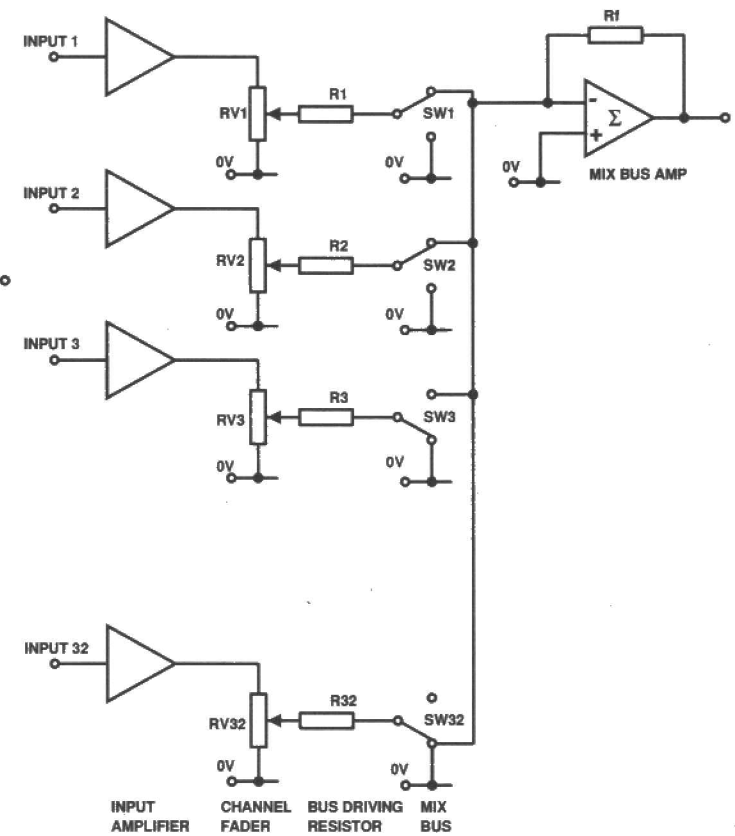
PROJECT



A. MUTING IMPLEMENTED BY INFINITE ATTENUATION-GROUNDING- OF BUS DRIVING RESISTOR USING CHANNEL FADER (OR LEVEL POT SUCH AS AUX MIX) ASSOCIATED WITH THAT SOURCE. CONTROL TURNED FULLY DOWN MEANS NO SIGNAL VOLTAGE AT BUS DRIVING RESISTOR, BUT RESISTORS REMAIN PERMANENTLY CONNECTED TO BUS, IRRESPECTIVE OF WHETHER OR NOT SOURCE IS ASSIGNED (FADED UP)



B. OPERATIONAL IMPROVEMENT ON A BUT NO MORE. SOURCES ARE ABLE TO BE ASSIGNED TO BUS A LEVEL DETERMINED BEFOREHAND BY THE CHANNEL FADER (OR LEVEL POT). CAN NOW BE 'MUTED' WITHOUT DISTURBING SETTING OF LEVEL CONTROL. HOWEVER, BUS DRIVING RESISTORS ARE STILL EFFECTIVELY CONNECTED TO THE MIX BUS REGARDLESS OF THE SETTING - MUTE OR ON - OF THE MUTE SWITCH.. NOISE GAIN IS STILL R_{BUS} x 32/Rf FOR ALL POSSIBLE SOURCE ASSIGNMENTS. IN SUMMARY, A NON-ECONOMICAL, ALMOST WORTHLESS USE OF SWITCHES AS FAR AS IMPROVED NOISE PERFORMANCE IS CONCERNED.



C. VAST IMPROVEMENT ON A AND B. OPERATIONAL CONVENIENCE OF MUTE SWITCH IS RETAINED, BUT POSITION OF IT AND BUS DRIVING RESISTOR TRANSPOSED. MUTING CHANNEL STILL GROUNDS BUS DRIVING RESISTOR BUT SIMULTANEOUSLY DISCONNECTS IT FROM MIX BUS. NOISE PERFORMANCE FOR A SMALL NUMBER OF SOURCES ASSIGNED TO THE BUS IS IMPROVED BY AN ORDER OF MAGNITUDE - AROUND 25 - 30 dB FOR A 32 INPUT BUS. DRIVING RESISTORS ARE CONNECTED TO THE BUS WHEN NEEDED. WITH A LARGE NUMBER CONNECTED, NOISE PERFORMANCE IS NO WORSE THAN A OR B.

Fig.1 Typical Aux mix muting arrangements

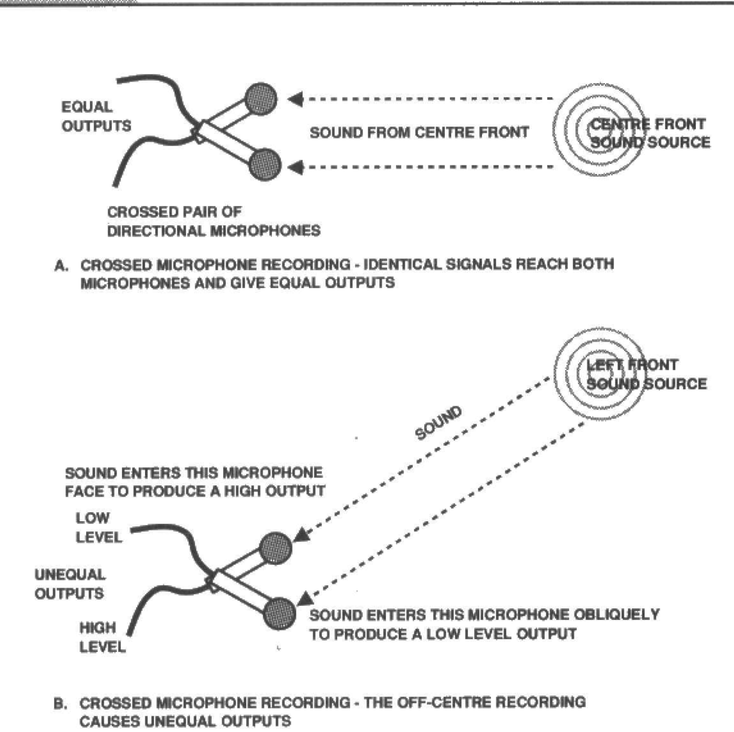


Fig.2 Crossed mic. recording

present on the bus. Surely there are no signals on the bus, since everything has been turned down or off? On the face of it, this would seem to be the case. Nevertheless, something is there and it gets amplified up - from -100dBu, say - by a factor dependent upon the number of paralleled resistors presented to the bus at a given time. It is then stuffed out, through the FX unit and back into the mixer at -70dBu (where it's audible) - regardless of the excellent specification of the FX unit. In our case, it will always be 31dB since the 36 bus driving resistors are permanently connected to the bus and the summing amp must always see 1/36 times the value of Rs.

Art of noise

What is this phantom plague of mix busses. Noise. Consider this scenario next time you blame an FX unit for excess noise. Figure 1c shows a way of eliminating this unfortunate noise amplifying phenomena. Turning a channel FX Send Off completely disconnects the associated bus driving resistor from the bus, so it doesn't appear as part of a parallel combination of any other bus driving resistors. Unless that particular channel is contributing to the bus, potentially noise-amplifying resistors are not connected. Furthermore, the noise needn't come from any, or all, of the sources. Noise on the ground or earth reference for the mix bus is just as likely a culprit, and contingency measures - outlined in Part 5 - must be taken to prevent ground noise ruining console performance.

This is the principle behind the AutoMate muting system and is employed on every mix bus. It's a principle which is applicable where the virtual earth mixing process is concerned. Here, gain for each signal input to mix-amp output is unity, regardless of how many individual resistors are present as a parallel combination at the virtual earth of the op-amp. It does not, extend to every mix bus in existence in every console, so if your console suffers in this aspect, it's not just a simple matter of a few two-minute modifications.

As far as the AutoMate muting is concerned, the manual version of the Aux Mix routing system does this by disconnecting the bus driving resistors from the bus via a mechanical, level pot backstop-operated switch. Similarly, the automated versions use FETs to isolate the resistors from the bus. Because four pole single throw switches aren't generally available fitted to the backs of potentiometers (which, from a cost point of view, is probably just as well), the manual version features non-balanced mix busses.

We've discussed at some length the many diverse routing requirements of the various types of desk - monitor, recording and broadcast - and illustrated the subject with examples. The one aspect which every routing has in common has been the centralised theme of the last few months - the switch. Before we leave the subject of routing, it's probably wise to look at one final area, although, strangely, there isn't a switch in sight. This is the panoramic potentiometer, to give it its rather grandiose full title, or pan-pot, as it's better known.

The routing of a signal, using a pan-pot, comes under the general heading of Spatial Localisation Processing. Since the early pioneering days of the stereo recording, there has been the need to position signals in a sound-stage of one sort or another. There is no such requirement when recording in mono, since there is no spatial localisation information available from this format. However, with modern stereo and the so-called multi-dimensional systems the engineer is capable of placing a particular source of sound anywhere along an imaginary straight line between the two speakers.

Where a recording is made direct-to-stereo (that is, captured using a stereo pair, either coincident, M and S, XY, or whatever), the placing both of the microphones and of the musicians determines the relative level of each sound source

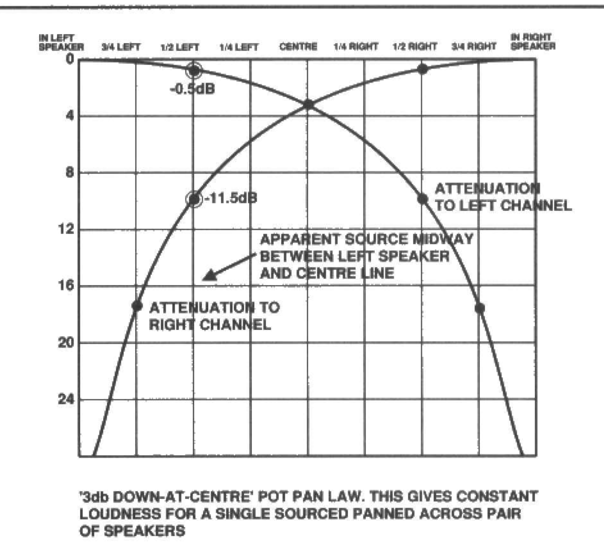


Fig.3 Constant loudness pan pot law

across the stereo image.

Two sound channels are the minimum required to achieve the stereophonic effect. This is not an accurate replica of the original sound field, as it might have been heard at the original venue, but an illusion or sensation of spatial distribution which enhances the apparent reality of the programme material. Although it might seem impossible to achieve an acceptable stereo effect with just two channels and two loudspeakers, since the ear can hear sounds coming from all

directions, our ears, using level and phase information, are deceived sufficiently by pure level distances between the left and right paths of a stereo pair into perceiving changing image position. From this, we are able to determine where within this image a particular source lies.

Stereo information is derived and captured using this technique shown in Figure 2. It is referred to as the coincident pair, or Blumlein pair, and modern examples use a pair of identical directional microphones placed as nearly as possible in the same point in space. There is minimum time-of-arrival difference at the two capsules and the whole of the directional (stereo) information relies on the controlled difference between the two mic. outputs.

In essence, this is the only genuine stereo recording, with all of the instrument placements captured on tape exactly as they were live.

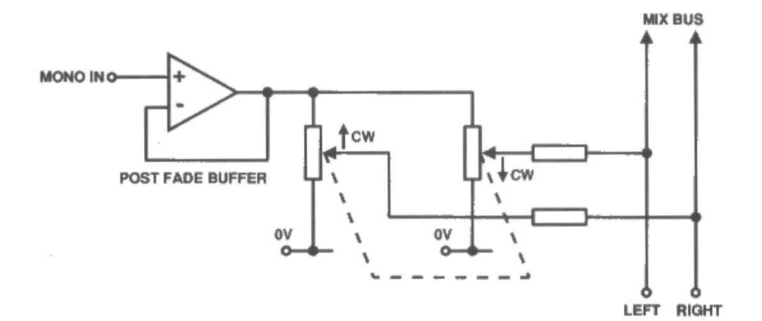
Synthesising Sound Placement using Level

Intuitively, the design of a control to position an image anywhere across the stereo field might seem like a fairly trivial task. In practise, this is seldom the case. The primary reason is mono compatibility. Although mono has traditionally been associated with old recordings and out-of-date, low-technology equipment, for many listeners, mono still forms the backbone of their enjoyment of recorded music. Mono radios are still in abundance and just because a track has been mastered using state-of-the-art digital mixing desks and recorders, doesn't necessarily mean that it won't end up as part of a programme which is then broadcast on short-wave to one of the far-flung corners of the globe. Mono compatibility is of primary importance in every aspect of recording and broadcasting.

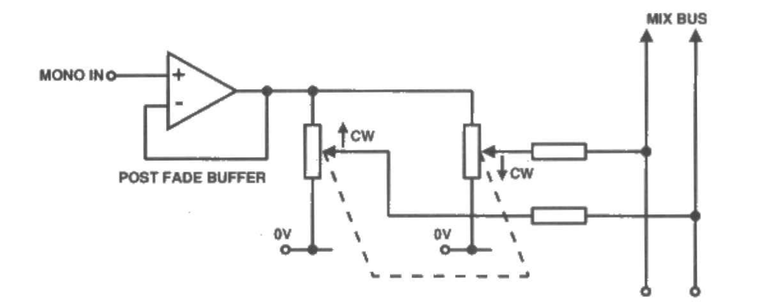
Consequently, the pan-pot must achieve a respectable stereo effect whilst leaving the mono signal untouched, or relatively untouched. Since potentiometers play an integral part in the system, it is not surprising that the curve which describes the characteristic of the pan-pot is known as the 'law'. Two basic laws are constant power and constant voltage, and they describe the way in which the control, across its travel, acts in dividing the mono input signal between the two output channels, and whether or not the sum of the two is constant across this travel.

A relationship was established between the proportion of signal level fed to two loud speakers and the apparent position of the sound source (see Figure 3). If the levels to right and left are controlled according to these curves, the power outputs from the two speakers will remain constant. In this way, a source panned from one channel to the other will not cause any apparent change in the level of loudness. This relationship equates to a sine/cosine law and, when desks were fitted with rotary stud faders et al, a double stud potentiometer (with precision resistors connected, as far as was practicable, to each of the studs), was commonly used to reproduce the desired law.

This '3dB-down-at-centre' law, as it is known, whilst causing a constant acoustic level from a pair of loudspeakers, causes some strange effects if the two identical -3dB signals are summed further down the signal chain. The resultant mono output voltage will be doubled, with the ultimate mono output from the system some 3dB higher with the pan-pot central than with it routing the signal to one side. A stereo signal summed to mono in a playback system suffers from the same problem. Incorporating a 6dB loss at the mid-point would correct this, at the expense of an apparent dip in level in the centre when on stereo. Somewhere between these two extremes lies a theoretical happy medium. Here, the signal will keep an even subjective level panning across the image plane. The amount of loss has been the subject of debate and controversy for many years, with proponents of the values 2, 3, 4 or 4.5 all arguing the case. Mono is most important in a broadcasting environment and here a compromise value of 4.5dB is often used.



A. PAIR OF GANGED, COMPLEMENTARILY - WIRED LINEAR POTS (OFTEN USED AS CHANNEL PAN-POT)



B. PAIR OF GANGED, COMPLEMENTARILY - WIRED LOG POTS (1dB DOWN AT CENTRE - OFTEN USED AS MULTITRACK ODDS/EVENS ROUTING CONTROL)

Fig.4 Log and lin pots configured as pan pots

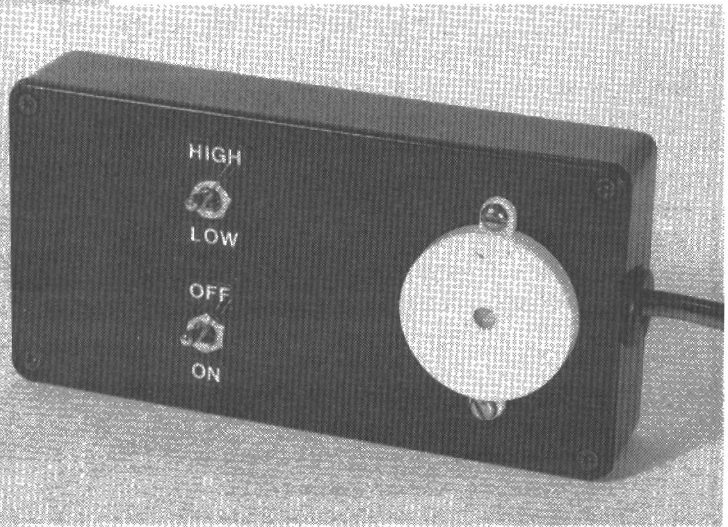
Pots and Pans

An example of what is probably the simplest of all pan-pots is shown in Figure 4a. Here, a ganged pair of linear potentiometers have complementary connections made to their tracks, such that as the output level from one increases, that from the other decreases. This type doesn't suffer from the drawback outlined above, since re-mono-ing the signals yields an output which remains at constant amplitude, regardless of pan-pot setting. However the subjective effect is one of too much loudness at the extremes of pot travel and diminished output in the middle.

Figure 4b shows a derivation of the simple type, with the linear law pots replaced by a pair of log/anti-log types, again ganged and complementarily wired. Panning right achieves a steady decrease in the level of the left output, with the right output remaining fairly constant in level. When the control is central, both outputs are attenuated only slightly with respect to original mono input. Subjectively, the image seems louder in the middle than it does at the extremes of settings, which is the opposite of the effect when linear pots are used. This kind of circuit is often implemented as a multitrack routing pan-pot, or as an offset control. Tracking between both halves of the pot is often not too good - certainly not as good as with a linear pot - because it is much harder both to manufacture the log law to accurate tolerances and to retain relatively low cost.

PROJECT

Continuity Tester



A piece of test gear that no experimenter should be without. A design by Robert Penfold

ETI Cover PCB Project

There are two common problems with continuity tester designs. One is simply that many testers indicate continuity when there is actually a significant resistance across the test prods. What is supposedly continuity can sometimes be resistances of up to a few hundred ohms. Also, many designs are 'fooled' by diode junctions. Such junctions are not just present in diodes, but also exist in transistors and integrated circuits. In fact modern circuits are liberally scattered with hidden semiconductor junctions that will give misleading results with any continuity tester that is not designed to ignore them.

The second problem is that of high currents flowing through the test circuit. Most continuity testers consist of an audio oscillator driving a loudspeaker, with the test prods connected in series with the battery supply. The full supply current of the continuity checker therefore flows through the test circuit. This is fine if the circuit is designed to consume no more than a few milliamps, but could cause damage to delicate integrated circuits if currents of 50mA or more are allowed to flow.

The continuity tester featured here avoids both problems. It has two sensitivities, one which requires a test resistance of less than 10 ohms before the audio tone is activated, and one which requires a test resistance of just a fraction of an ohm. This second mode is useful when testing circuits which contain very low value resistors and (or) small inductors which exhibit low resistances. When set to either sensitivity, diode junctions will not 'fool' the unit into producing false indications of continuity. The current flow through the circuit under test is a mere 4mA or so, which is too low to damage any normal components.

System Operation

This continuity tester uses the basic arrangement shown in the block diagram of Figure 1. The operational amplifier is used here as a voltage comparator. If the non-inverting (+) input is at a higher voltage than the inverting (-) input, the output will go high. If the inverting input is at the higher voltage, the output will go low. The output of the comparator controls a gated audio oscillator which drives a small loudspeaker. Strictly speaking, the oscillator is a complement gated type and it is therefore switched on when the control signal is low, and switched off when a high control level is received.

R2 and R3 form a potential divider across the supply rails. Their function is to provide a reference voltage to the inverting input of the comparator. R1 takes the non-inverting input to the full supply voltage under standby conditions, which in turn sends the output of the comparator high. Thus the audio oscillator is gated off under standby conditions.

Connecting a true short circuit across the test prods results in the non-inverting input being taken to 0V and it is then at a lower potential than the inverting input. This results in the comparator's output going low and the audio oscillator being activated. Of course, it is not essential to have zero resistance across the test prods in order to activate the unit. The resistance here merely has to be low enough to take the potential at the non-inverting input below that at the inverting input. Just what constitutes a low enough resistance to achieve this depends on the values of R1 to R3.

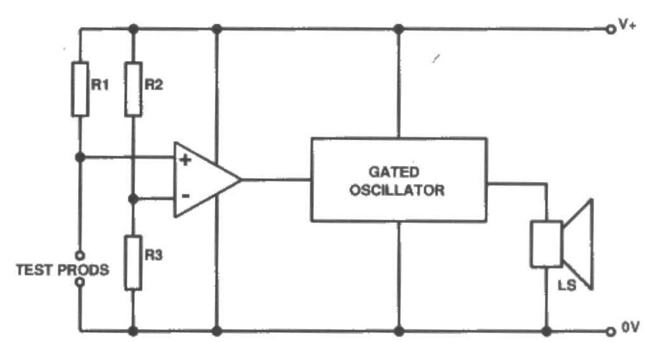


Fig. 1 Block diagram of continuity tester

Unlike many continuity testers, this one does consume power when the test prods are open circuit, so on/off switch SW2 is therefore needed. Under standby conditions, the circuit has a current consumption of only about 3mA, but the consumption rises to about 8mA when the unit is activated. A PP3 size battery is adequate as the power source.

Construction

The component overlay for the printed circuit board, plus the small amount of hard wiring, is shown in Figure 3. Both

the integrated circuits are MOS types and, accordingly, they require the normal anti-static procedures to be observed. The most important of these is to use holders for the two integrated circuits. They should only be fitted into their holders once the unit has been completed in all other respects. Both devices should be left in the anti-static packaging until then.

In other respects, construction of the board is extremely simple. Single-sided solder pins are fitted to the board at the points where connections will eventually be made to off-board components such as LS1 and SW1. The tops of the pins should be tinned with a generous amount of solder. Unusually for modern components, some solder pins seem to be reluctant to take a proper coating of solder. If this should occur, clean the pins by scraping them with the blade of a penknife, prior to tinning them.

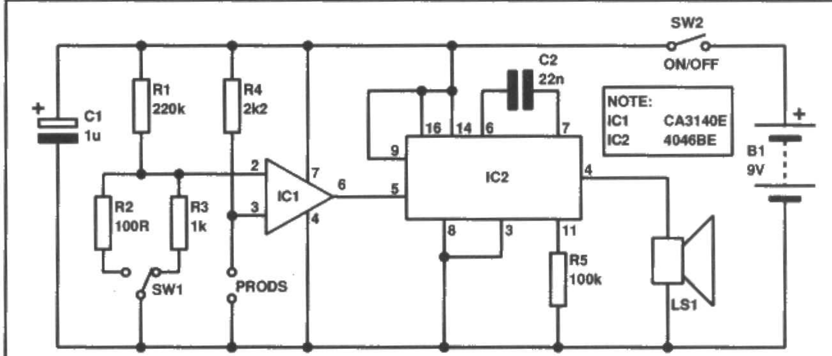


Fig. 2 Practical circuit

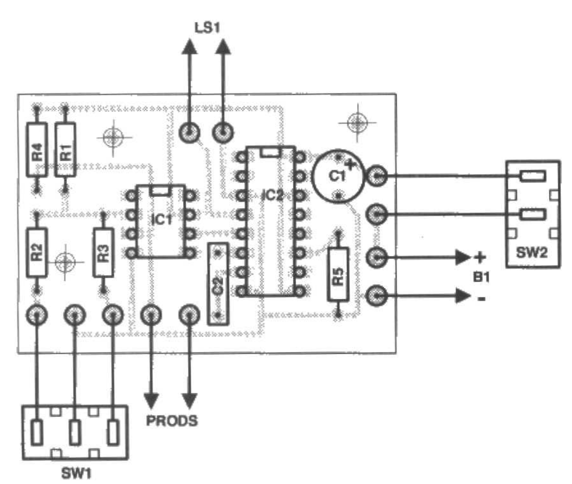


Fig. Component overlay

The case for the prototype is a small plastic box, which has approximate outside dimensions of 110 ∞ 56 ∞ 20mm. It is unlikely that the unit could be fitted into a case which is significantly smaller than this in any dimension. The printed circuit board is mounted on the rear panel, well towards one end of the case, using 6BA or metric M3 fixings. The battery fits into the space at the opposite end of the case, leaving room for SW1 and SW2 in the middle section of the case. The switches are mounted on the front panel/lid of the case.

LS1 must be a cased ceramic resonator which is intended for screw fixing to a case (not an uncased element or a cased type intended for printed circuit mounting). Most require two small (M2 or 8BA) fixing screws. A third small hole is needed in the case to accommodate the resonator's two flying leads. LS1 is mounted towards the right hand end of the front panel, in front of the circuit board. The resonator itself can be used as a template when marking the positions of these three holes. Note that LS1 must be a ceramic resonator and that this circuit can not drive a moving coil loudspeaker. The test prods could be connected to the circuit board via a pair of plugs and sockets, but it is advisable to use direct connection to the circuit board. This ensures that the prods will be in really good electrical contact with the circuit board, which is essential if the unit is to operate properly in the low resistance mode. An entrance hole for the test leads is drilled in the centre of the right hand end panel of the case.

HOW IT WORKS

In the practical continuity tester circuit of Fig.2, IC1 is the comparator. The reference voltage to the inverting input of IC1 is provided by R1 and either R2 or R3, depending on the setting of SW1. For the moment, assume that R3 has been selected, which places the unit in its high resistance mode. This gives a reference voltage that is only about 1/220th of the supply voltage, approximately 40mV. R4 biases the non-inverting input to the positive supply rail and the important point to note here is that its value is only 1/100th of R1's value. Therefore, the resistance across the test prods must be 1/100th the value of R3 (10 ohms) in order to balance the input voltages to IC1. The resistance across the prods must be fractionally lower than this in order to activate the audio oscillator.

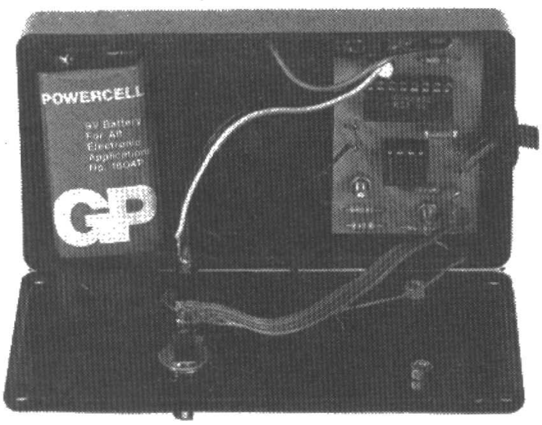
For general purpose testing, this gives good results. Few circuits contain many resistances that are below 10 ohms, so there should be few false alarms. On the other hand, if dirty printed circuit tracks, or something of this nature, should produce some less than perfect electrical contacts with the test prods, this should not be sufficient to prevent the device from being activated properly. Silicon diode junctions will not produce misleading results either. Less than about 40mV must be present across the test prods in order to activate the alarm. The voltage drop across a silicon diode is over ten times this figure. There is no danger of the unit producing high currents which would damage the circuit under test. R4 limits the current flowing through the test prods to a safe level of about 4mA.

The circuit operates in much the same way in the low resistance mode. SW1 is then set to select R2. This reduces the reference voltage at the inverting input by a factor of around ten times, since R2 has a resistance which is only 1/10th of R3's resistance. The main practical consequence of this is that the resistance across the test prods must now be less than 1 ohm (i.e. 1/100th of R2's value) in order to activate the tone generator. If desired, the value of R2 could be made lower, in order to make the maximum acceptable test resistance lower as well.

In practice, it is probably best not to use a value of much less than 100R. Firstly, bear in mind that there will be a certain amount of resistance through the test leads. If the unit is made too discriminating, this could be sufficient to prevent it from operating properly. Also, bear in mind that it might sometimes be difficult to get really good electrical contacts between the test prods and the printed circuit tracks, etc., in the test circuit. Even with R2 at 100R, bad contacts could easily result in misleading results unless adequate care is exercised when using the unit. The audio oscillator is a simple voltage controlled oscillator (VCO) based on IC2, a CMOS 4046BE. In this case it is used at a fixed frequency with the control input at pin 9 simply wired to the positive supply rail. The operating frequency is around 700Hz, which is too low to give peak efficiency from LS1. This component is a cased ceramic resonator. In this application a tone of moderate volume is all that is required and it would be undesirable to use a higher frequency that would give a powerful tone from LS1.

Complete the unit by adding the small amount of point-to-point wiring. This is very straightforward and should present no difficulties. Although most ceramic resonators have one red lead and one black lead, LS1 can in fact be connected either way round.

Testing And Use



With the unit switched on and the two test prods connected together, the audio generator should be activated, regardless of SW1's setting. With SW1 set to the high resistance mode (i.e. R3 selected), the audio alarm should be activated if a 4R7 resistor is connected across the prods. However, changing to a 22R resistor should not give a response from the unit. With the tester set to the low resistance mode (i.e. R2 selected), connecting the 4R7 or 22R test resistors across the test prods should fail to activate the audio tone generator. Using a 0R47 resistor should result in the tone generator being activated.

In normal use it is probably best to use the high resistance mode. The unit is not easily 'fooled' when in this mode, and something less than really good connections to the test circuit will give satisfactory results. The low resistance mode is better when the circuit under test is known to contain a lot of low value resistors, small inductors, RF transformers, etc.. However, when using this mode it is essential to ensure that the test prods make good contact with the test circuit.

PARTS LIST

RESISTORS (0.25W carbon film)
R1 220k
R2 100
R3 1k
R4 2k2
R5 100k

CAPACITORS
C1 1µ63V radial elect
C2 22n polyester

SEMICONDUCTORS
IC1 CA3140E
IC2 4046BE

MISCELLANEOUS
S1 SPDT sub-min toggle
S2 SPST sub-min toggle
LS1 Cased ceramic resonator
B1 9V (PP3 size)
Printed circuit board
Case about 111 ∞57 ∞22mm
8 pin dil holder
14 pin dil holder
Test prods and leads
Wire, solder

Sega Switchbox

An easy to construct switcher for the kids, by David Silvester.

Father Christmas was rather generous to my sons last year, as we acquired a Sega Megadrive games system - along, I suspect, with a rather large proportion families. For most games, the joypads supplied with the unit are fine but for those of us who find that after a while you get thumb ache, or when playing flight simulator games, a joystick or touch sensitive joypad is better. Fine you say, just plug in the one you want, which is all very well, but in a short time the sockets will wear and you will get problems.

However, all is not lost. Luckily, the Sega system appears to use a standard 9 pin D connector for the joypads. The answer is to use a switchboard to select the joypad or joystick as required. The problem is that no-one makes one. Centronics parallel and 25 way RS232 switchboxes, yes, but 9 pin D type connectors - no way, well not at a sensible price anyway. At this point I started to consider whether such a simple item really constituted a project, but it was my wife who said "If you can't buy it, then it will be of interest". In addition, the switchbox suggested here is suitable for use with a standard 9 pin RS232 output as found on most IBM compatible personal computers.

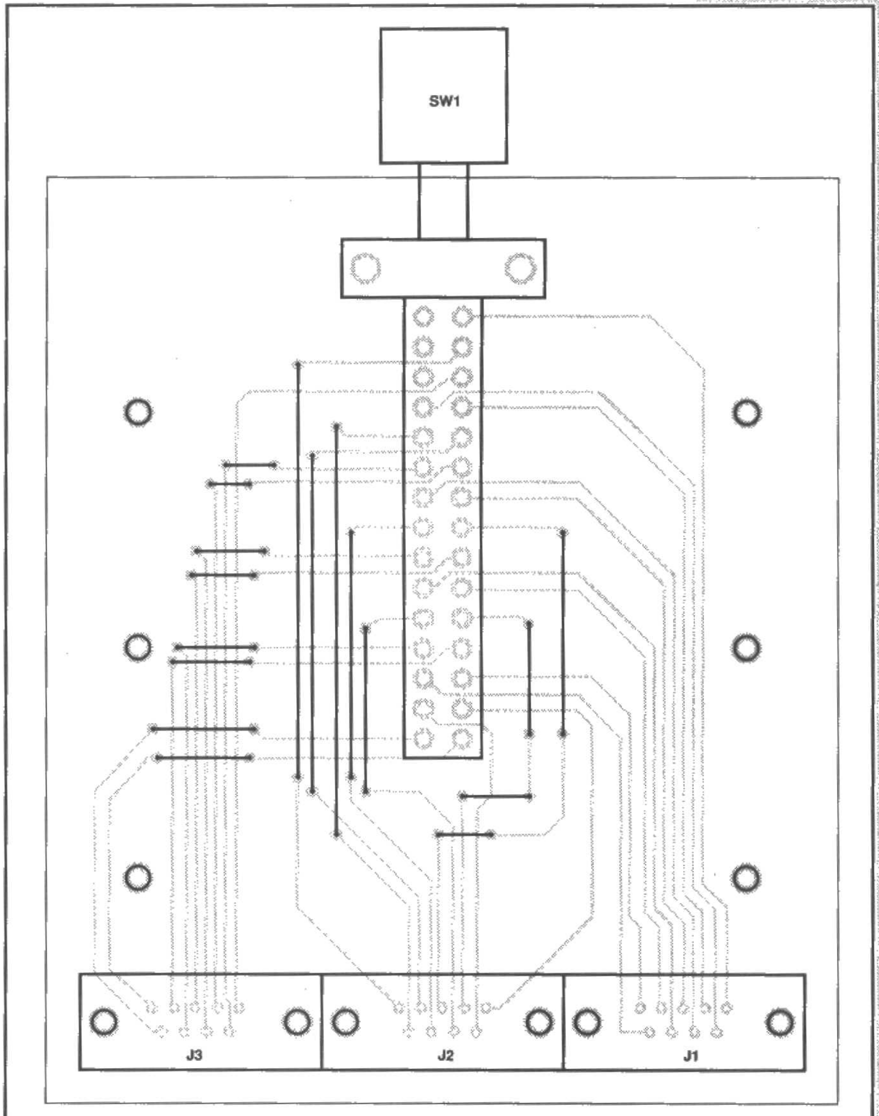


Fig.1 Component overlay

Construction

Unlike most of the projects in ETI, there is no How it Works section, as the use of a 10 way change-over switch to change over 9 signal lines is just too simple. With the D connectors, the outside pair must be of the same type (either male or female), while the centre one is of the opposite type.

Initially open the case and check that the PCB will fit on the small support studs. The PCB is a tight fit, it will nearly touch both the front and back aluminium panels in the box and it is easier to check at an early stage. If there is a problem, the PCB will need to be filed until it fits, but be careful not to damage any of the tracks. Next, check the position of the six small supports and mark the PCB where the mounting holes have to go, then drill the holes. There are six screws supplied with the box that fit the supports.

Figure 1 shows the PCB layout. To save cost, the PCB is single sided and uses link wires on the component side for the other connections. Fit the bracket to the switch and add the push button. Following Figure 1, mount the switch, the 9 pin D connectors (remember - outside pair the same type) and the link wires.

The box chosen is symmetrical top and bottom except that the bottom has holes for the securing screws. Take the top of the box and insert the front and rear panels back to front, i.e. with the surface that does not have the protective coating on the outside. Then leave it upside down. Fit the completed PCB into the box bottom. Since the two box halves are the same size, by placing the top and bottom together on a flat surface it is easy to mark the front and rear panels where the switch button and D connector holes should go. Drill a small hole then use an abrafile or a holesaw to cut out the correct size holes. Remove the PCB from the lower box section, place the holes cut out over the switch and the D connectors and, if all is well, then the PCB can be refitted into the lower box half with the panels fitting into their slots. It may be necessary to ease open some of the holes with a file to make everything fit correctly. Lastly, mark the position of the mounting screw holes for the D connectors, dismantle, drill the holes and reassemble with filing screws.

Conclusions

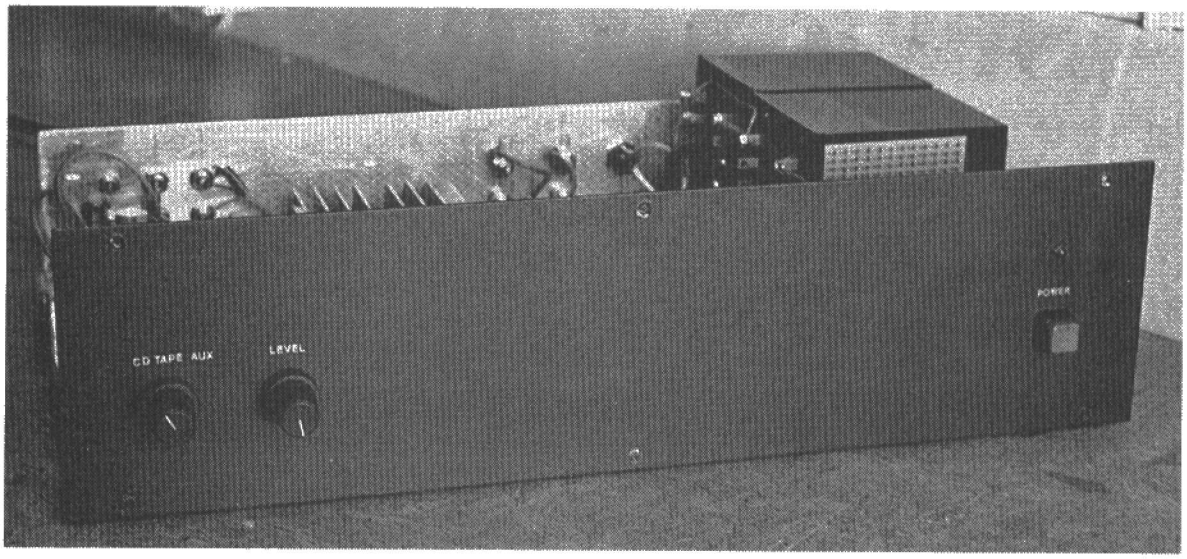
I think you will agree that the box is a simple but useful connecting box and it was certainly worth the effort in our case. I hope you think so too!

PARTS LIST

10 pole switch	Cirkit Code 53-77010
Switch bracket	Cirkit Code 53-75100
Switch button	Cirkit Code 53-11509
ABS Case	Cirkit Code 21-15992
D female	Cirkit Code 10-62247,
D male	Cirkit Code 10-62248
Screws for D connectors	

BUYLINES

When ordering the D connectors you will need two of one type and one of another. Since they are low cost items it is possibly easier to buy two of each rather than find you have made a mistake when the parts arrive. The saving in postal charges makes it worthwhile.



Up-Grading a Transistor Amplifier

by L.Boullart

Since the advent of the power MOSFETs, the popularity of the transistor amplifier for high-fidelity applications has somewhat declined. Is it possible to improve the performance of the bipolar transistor up to the point where it can compete successfully with its MOSFET counterpart? Not quite, but as the specifications of the present design show, the performance can be lifted a good deal above the average, without the use of unduly complicated circuitry. During the design of a MOSFET amplifier, I made some inquiries into the behaviour of the high-frequency response and distortion with respect to phase-frequency-compensation networks. The results, presented here, were highly interesting:

1. Any kind of phase-frequency compensation, in order to ensure unconditional stability in a feedback amplifier, will increase harmonic distortion in the upper frequency range.

2. Increasing the gain of the pre-amplifying stages will give a higher feedback ratio, but the expected reduction of harmonic distortion will be lost again, owing to the need for heavier compensation. Besides, it will become more and more difficult to avoid random oscillations.

3. It follows, therefore, that unconditional stability in a feedback amplifier should depend essentially on the inherent properties of the circuit. This implies that stability must be guaranteed at all signal levels and frequencies, with all kinds of waveforms and with inductive loads.

SPECIFICATIONS

Nominal power output:	50 Watt	
Sensitivity:	600mV	
Signal/noise ratio:	-106dB (90µV)	
Feedback factor:	60dB +/-2dB	
Harmonic distortion:		
10 Watt:	1kHz :0.006% (hum and noise included)	
	10kHz :0.03% (2.9mV)	
50 Watt:	1kHz :0.016% (3.2mV)	
	10kHz :0.033% (6.6 mV)	
Efficiency (50W)	58%	

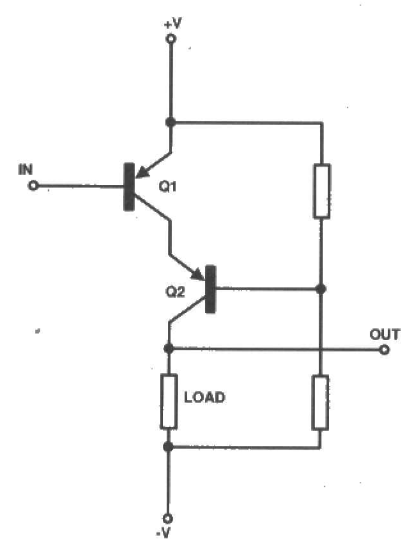


Fig.1 The Cascode circuit

The Case For The Preamplifier

The requirements for a preamp may be summarised as follows:

a) High amplification factor

b) Linear response within the audio-frequency range

c) Low harmonic distortion.

Feeding the input stage and the driver from a current source and using current mirrors as load resistances, it is possible to obtain amplification factors up to 150,000. Unfortunately, there will be a considerable loss of high frequencies and an unfavourable degree of phase-shift, which will make stability a major problem. Several compensation networks

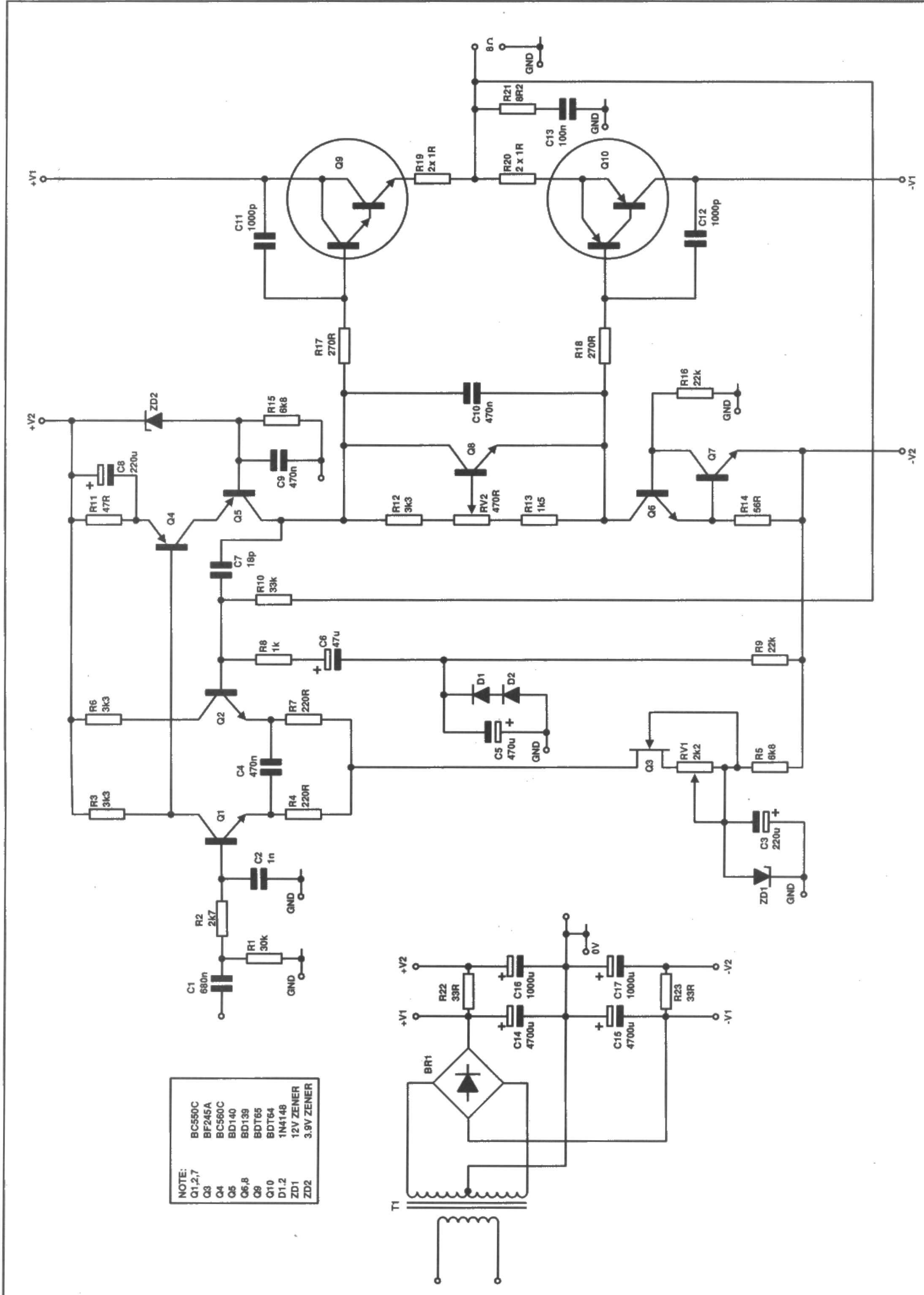
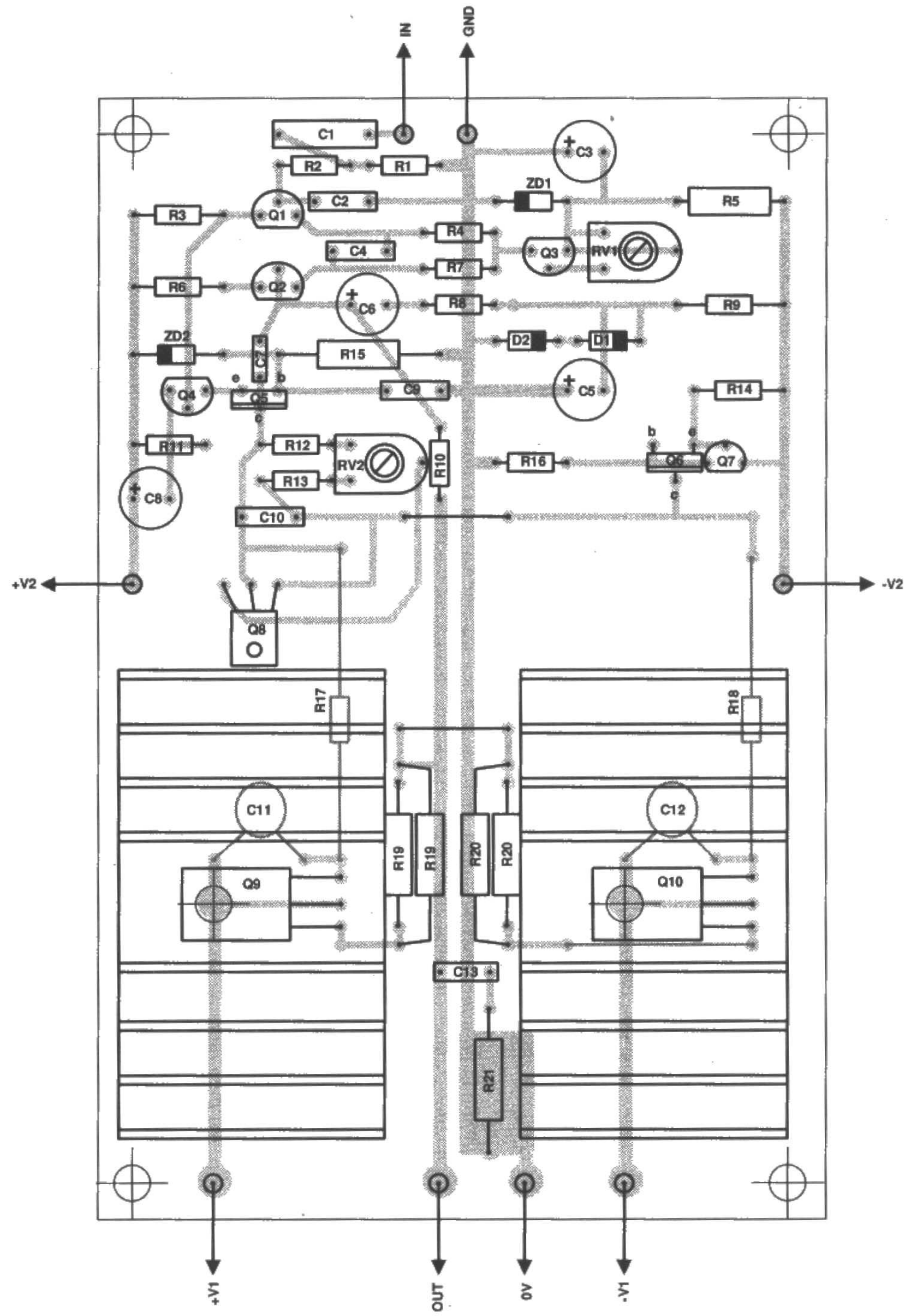


Fig.2 Main amplifier circuit



C11, C12, R17, R18 MOUNTED ON FOIL SIDE OF BOARD

Fig.3 Component overlay for main amp

will be needed, with the inevitable result of increased distortion and poor transient response. With less gain and better frequency response, these problems can be overcome. In this way, the overall feedback ratio could be reduced without ill effects on harmonic distortion and transient response.

There is a device which will help us to reach our goal. This is the cascode circuit in Figure 1. Transistor Q1 has a common base configuration. The Miller effect is therefore eliminated and a high load resistance can be used. On the other hand, Q1 is loaded by the low input impedance of Q2. Together they make up a high gain stage with excellent high frequency response.

Another important feature is the low distortion level, owing to the complementary characteristics of Q1 (common emitter) and Q2 (common base). The test results of the preamplifying part of the complete circuit (see Figure 2) are approximately as follows:

Gain	91dB (36000x)
Frequency response	-3dB at 18kHz
Distortion	0.15% for 20Veff at 1kHz
	0.35% for 20Veff at 10kHz

The Complete Circuit

From the input, the signal first goes through the lowpass filter R2, C2, which attenuates supersonic frequencies above 60kHz. Q1 and Q2 are a long-tailed pair, fed from a FET current sink Q3. A FET transistor is an excellent current sink because in the pinch-off region, drain current is almost completely independant of drain voltage. Q3 works a -12V tension by means of Zener diode ZD1; the trimpot RV1 is used to equalise the collector currents of Q1 and Q2. For a perfect balance, both transistors should have equal base resistance, hence the somewhat unusual value for R1. Total resistance for R1 + R2 is 32k7, which will allow the use of a non-polarised capacitor for C1. But for C6 - which is also in the signal path - we have to choose an electrolytic; so we have included a polarisation network consisting of R9, C5, D1, D2.

At first sight, the driver stage (Q4...Q7) looks like a symmetrical design. This is not the case: the upper part with Q4, Q5 is the cascode, whereas the lower half (Q6, Q7) is in fact a stabilised current source. Resistor R14 is used to polarise Q7. Because Vbe for Q7 is approximately 620mV, the fixed current of the complete stage is 620mV/56R = 11mA, which will be more than adequate to provide the driving current for the output transistors. The voltage at the base of Q5 is stabilised by ZD2, R15, C9. Feedback is applied to the base of Q2 through R10. The gain of the complete amplifier is then determined by the ratio R10/R8 (approx. 34). Since the initial gain (without feedback) is approximately 36,000, we have a feedback factor of 36,000/34 ∪ 1000 or 60dB. With this heavy feedback it becomes necessary to apply a small amount of phase/frequency compensation. This is taken care of by C7, from the collector of Q5 to the base of Q2. Values between 5 and 33p are suitable, depending upon individual parameters of the transistors involved, but 18p is a good compromise. The effect of C7 on audio frequencies is negligible, but its presence will ensure absolute stability. Power supply for the preamplifying stages is applied through R22, C16 and R23, C17 on the power supply PCB. The use of separate decoupling networks gives a better signal to noise ratio as well as a small increase of music-power output.

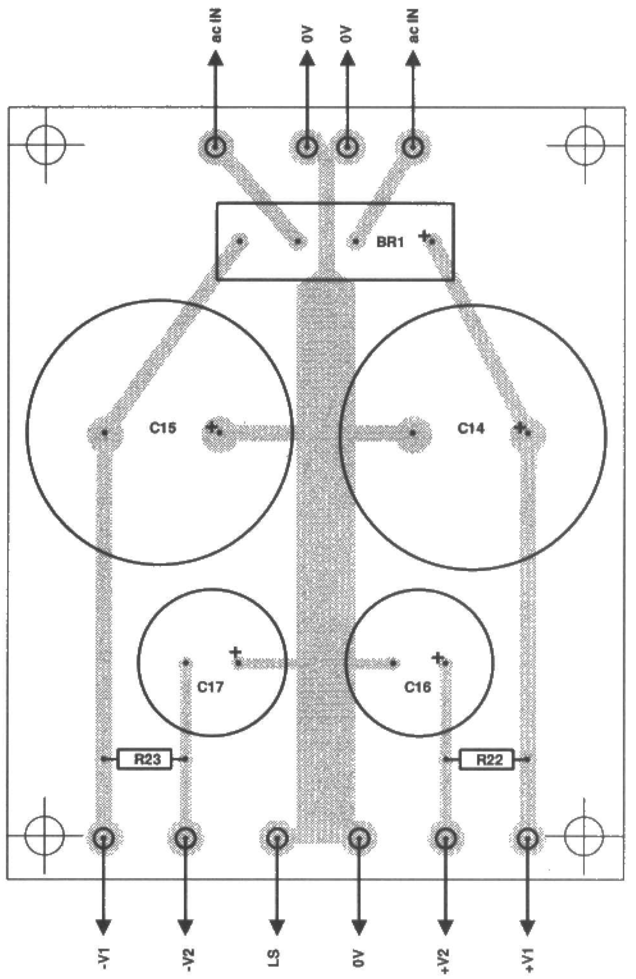
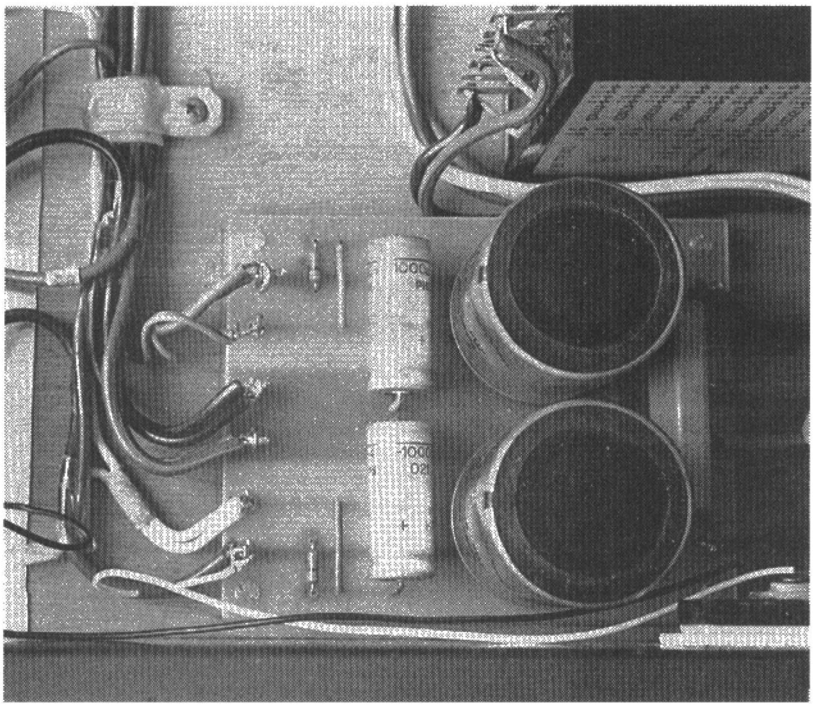


Fig.4 Component overlay for power supply



Q9 and Q10 as complementary Darlington emitter followers with a gain of less than 1; even so they are responsible for the major part of the distortion contents, hence the need for heavy feedback. Quiescent current for Q9 and Q10 is adjusted to 60mA by means of RV2 together with transistor Q8. Power output is limited to 50W -still an awful lot of noise in the ordinary living room. Medium sized heatsinks for the power transistors can be used and mounted directly on the PC board without separate wire connections and without insulating accessories. Thermal stability is accomplished by screwing Q8 (BD139) firmly to the heatsink for Q9. Beware: the metal part of Q8 must be insulated from the heatsink with a mica washer! R17, C11 and R18, C12 are used to avoid self-oscillation. They should be mounted on the copper side of the board, as near as possible to the base of Q9, Q10. R19 and R20 consist of 2 x 1R at 1W each. Do not use wire-wound resistors here. The usual Zobel network across the output consists of R21 and C13.

Practical hints

The complete amplifier is mounted on a Eurocard-size epoxy PCB (100 x 160mm), half this size (100 x 80mm) is needed for the power supply unit.

The heatsinks are type KL107/37.5 with dimensions 70mm x 37.5 W. Other types for T0220 envelope are equally suitable, provided the temperature coefficient is below 3.2°C/W. Of course, with larger heatsinks, the length of the board must be increased. The power transistors and their heatsinks must be fixed very carefully on the PCB; apply sufficient heat-conducting compound to the metal tab of the transistors.

R17,18 and C11,12 are soldered on the copper side, as well as a wire link for the emitter of Q10. On the component side there are two links.

For a stereo version, the power supply capacity must be increased. TR1 = 225VA, BR1 = B80C8000, C14,15 = 10000µ, C16,17 = 2200µ.

Preliminary Adjustments

a) Insert a milliammeter in the V1+ line between power supply and amplifier. Turn RV2 fully anti-clockwise, then switch on power and adjust RV2 for a quiescent current of 60mA.

b) Measure the voltage on the output. If everything is correct, this voltage will be below 20mV.

c) Adjust RV1 for equal currents in Q1 and Q2: connect a 10 or 20M FETVOM or a digital meter across R6 through a 10k resistor, connected to the collector end of R6 (to avoid unwanted oscillations) and turn RV1 until you read between 1.3 and 1.4V.

PARTS LIST

Resistors (0.3W 1%)

R1	30k
R2	2k7
R3,6,12	3k3
R4,7	220R
R8	1k
R9,16	22k
R10	33k
R11	47R
R13	1k5
R14	56R
R17,18	270R
R22,23	33R
RV1	2k2
RV2	470R

Resistors (1W 5%)

R5,15	6k8
R19,20	2 x 1R each
R21	8R2

Capacitors (MKM)

C1	680n
C2	1n
C4,9,10	470n
C13	100n

Capacitors (ceramic)

C7	18p
C11,12	1000p
C3,8	2200µ/16V
C5	470µ/6V
C6	47µ/6V (low leakage or tantalum)
C14,15	4700µ/50V
C16,17	1000µ/50V

Semiconductors

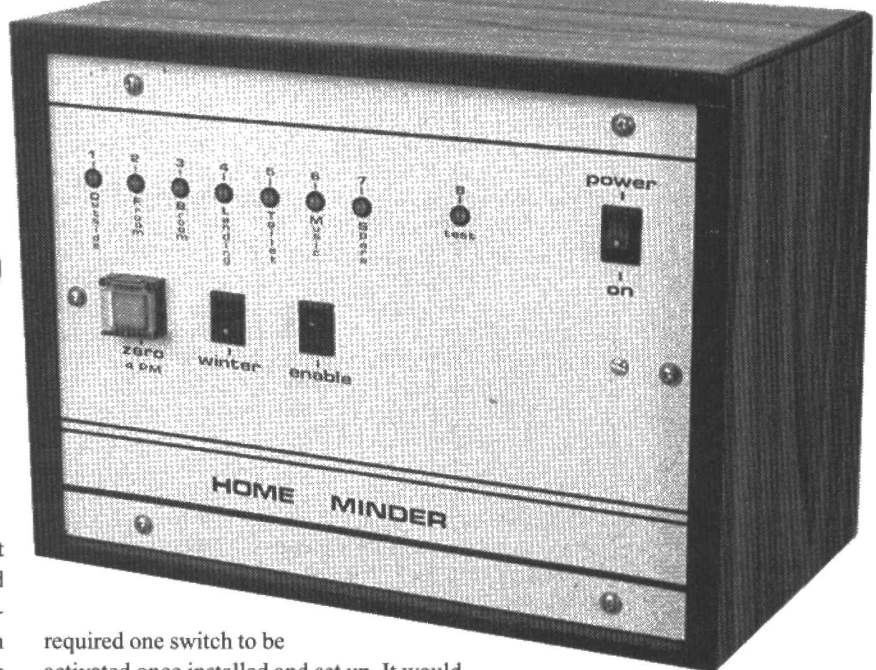
D1,2	1N4148
ZD1	12V Zener
ZD2	3V9 Zener
Q1,2,7	BC550C
Q3	BF245A
Q4	BC560C
Q5	BD140
Q6,8	BD139
Q9	BDT65
Q10	BDT64

Miscellaneous

TR1 Transformer 120VA 2 x 30V
BR1 Bridge rectifier 80V, 5A
2 PCBs
2 heatsinks 3.2°C/W or less
(KL 107/37.5 or similar)

d) A final remark: the amplifier has been designed for an 8R load. Higher loads will give less power output, but lower loads may cause damage to the amplifier, due to overheating of the output transistors, in case of continuous full power operation.

Home Minder

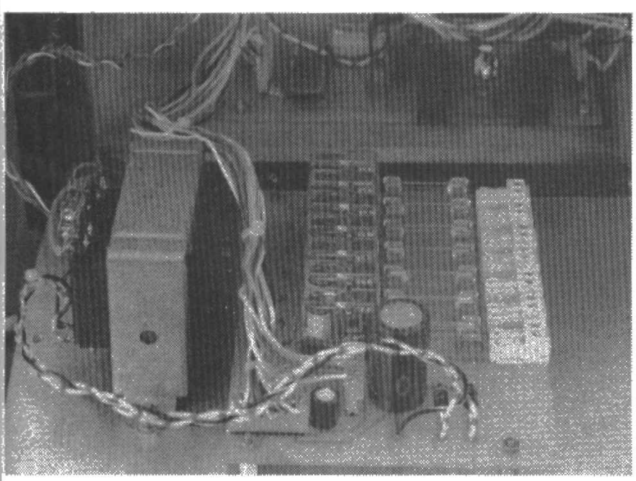


Bob Noyes deters the burglars with his house minder

Reducing the risk of break-ins was a topic raised at a Neighbourhood Watch talk which I attended recently. A lot of house break-ins are of an opportunistic nature, where someone walks around in the evening passing the same houses several times, looking for those either in total darkness or with a landing or hall light on only.

Such houses are singled out as potential targets because their owners are almost certainly out. Although a burglar alarm can be fitted and is expected to be set off when the house is broken into, there is always the feeling that someone has been in your home and may well have done major damage during entry. Far better to discourage burglars from attempting to break in in the first place, by making your home appear to be buzzing with activity.

All this seemed pretty obvious and what was needed was something that would switch lights on and off in a controlled



fashion, suggesting to the casual passer by that the house was occupied. Single channel timed light switches are readily available, but on the whole these turn on and off once per 24 hours - not really giving the appearance of normality. Several of these could be used in different rooms to give a more realistic effect, but all require suitable table or standard lamps and all the clocks require setting up. This means leaving maybe four or five time clocks running all day and all night and even then they would all have to have their lights activated when required - altogether an impracticable solution when you're in a hurry to go out.

What was needed was a custom designed unit that only required one switch to be activated once installed and set up. It would need to be crystal controlled for long term accuracy and have battery back up for accurate time keeping, even in a power cut, because if the clock stopped and restarted, the lights would come on late depending on the length of the power cut. It must have a summer and winter set of commands because lights are switched on earlier in the winter and stay on longer in the mornings than in the summer. The 'program' would have to be able to be tailor made to the type of building and family it served. In all quite a tall order, but Home Minder achieves all this - and for a very affordable price, considering the peace of mind given when either going out for the evening or away on holiday for a couple of weeks.

Unfortunately, no guarantees can ever be given, no matter what security measures are undertaken, that a break-in will not occur but I can say quite confidently that with Home Minder installed and working, a break-in is far less likely when the house is unattended. With the music channel on as well, even in the early evening before lighting up time, the house would have the feeling of being occupied.

How It Is

The principle of operation is basically a crystal controlled clock that gives a pulse every minute. This is fed to a counter that recycles every 24 hours or 1440 minutes. From between 4pm and 9am, every minute can be individually programmed to switch up to seven different electrical circuits in any combination and in any order, the object being to switch lights on and off in a controlled manner to give the impression of someone being in. Here's the idea. The outside light comes on just before dusk, followed later by the front room light. Music can be switched on and off during the evening as can the bedroom and toilet lights. The music and front room lights are turned off first and the bedroom and toilet lights are turned on at bedtime. These are then turned off in due course imitating the normal routine of the house. These instructions as to which lights are on or off and when they are turned on and off are held in a program of an EPROM. The one used here is a 2716 - although small in capacity in modern terms of Megabits, its 2048 bytes are capable of storing two programs, one for winter, the other for summer, selected on a switch Summer/Winter.

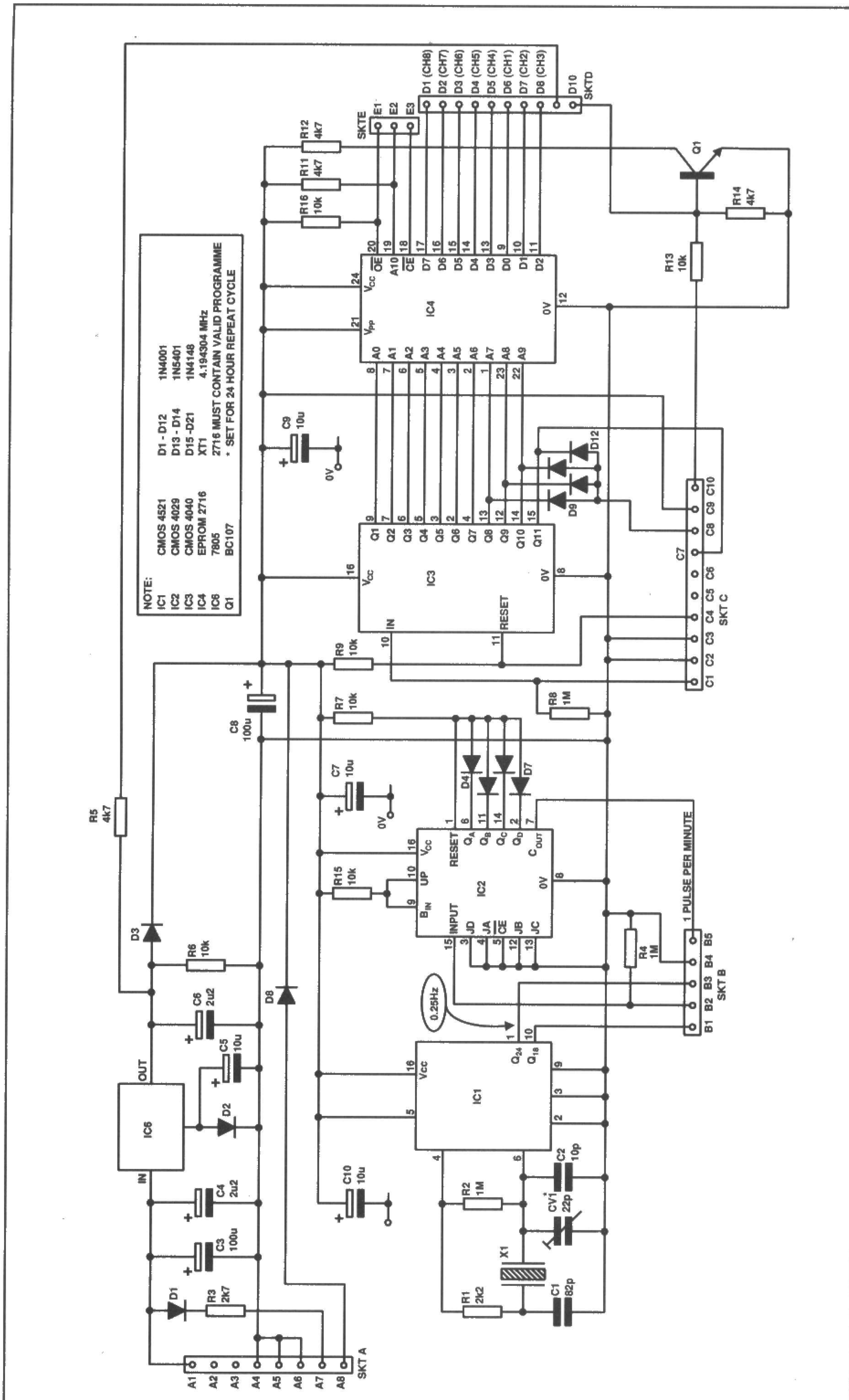


Fig.1 Main control board circuit

PROJECT

HOW IT WORKS

A crystal oscillator of 4.194304MHz is built around IC1, a CMOS 4521 This IC contains most of the oscillator circuit and the dividers necessary to produce a 0.25Hz output at pin 1, i.e. 4.194304MHz divided by 2 twenty-four times gives a frequency of 0.25Hz. Also Q18, a 16Hz signal is taken from pin 10 - this is used to test the program in fast mode (see later in the text). The 0.25Hz is normally connected to a divide by 15 circuit built around IC2, a CMOS 4029. The 4029 counts in binary and would normally reset at 16, but by the addition of D4, D5, D6, D7 and R7 it now resets at 15. The effect of a 0.25Hz signal divided by 15 is to produce a pulse every minute. This is taken from the carry out pin 7. None of the jam inputs are required so they are all grounded. The $\overline{\text{carry in}}$ pin 5 is always enabled so is grounded. A '1' on pin 10 causes it to count up, while a '1' on pin 9 makes the 4029 count in binary.

The pulse every minute is counted by IC3, a CMOS 4040, a 12 bit binary counter. Normally, this would count to 4096 before starting again from zero, but with the addition of D9, D10, D11, D12 and R9 it resets after 1440, the number of minutes in a day: 60 ∞24 = 1440. This is done by taking

Q6	32 count	Pin 2
Q8	128 count	Pin 13
Q9	256 count	Pin 12
Q11	1024 count	Pin 15
=	1440 count	

and forming an AND gate, so when Q6, Q8, Q9, Q11 are all high, the reset goes high, via the pull up R9. The switch that connects the common point of the diodes to the reset should be of the normally closed type. In order to synchronise and zero at 4pm, the 'zero' switch is normally pressed at 4pm. Then, assuming the Home Minder is not turned off, the counter will recycle and zero at 4pm every day automatically - even if the outputs are disabled.

If the mains fails, the crystal oscillator and counters remain working via the battery back up. When the mains fails, the -15V stops causing the regulator to be starved of power. The 5V +0.7 due to D2 no longer appears at the output of the regulator. D8 now becomes forward biased allowing the battery supply 4.8 nominal voltage - 0.7 across D8 to supply the board and being CMOS, this is enough to maintain correct operation of the circuit. For the duration of the power failure, the EPROM is disabled via Q1 causing $\overline{\text{CE}}$ chip enable to be pulled high by R12, normally the 5.7V supply is used via R5, R13 to turn on Q1 keeping $\overline{\text{CE}}$ low and hence the EPROM working. Removing $\overline{\text{CE}}$ considerably reduces the power' consumption while on battery back up, allowing for even the longest power cut not to affect the overall timing (of course the outputs will not operate, but with no mains the lights would not work anyway).

When a circuit containing a battery back up system is switched off deliberately, it must be remembered that not only the mains must be switched off, but the battery line must also be switched or all that will happen is that the batteries will take over and eventually run down because they are no longer being trickle charged.

The 2716 EPROM only has 2048 memory addresses and, as stated there are 1440 minutes in a day and two programs would normally require 1440 x 2 = 2880 addresses. This problem is overcome by not connecting A10 on the EPROM to the counter Q11, but to a 'Winter/Summer' switch. This means that addresses 0 - 1023 are used for the winter program and 1024 - 2047 for the summer program. The Q11 (1024) output from the counter IC3 is connected to the $\overline{\text{OE}}$ output enable of the EPROM. This means that from count 1024 to 1440, the outputs from the EPROM are disabled but as this happens at 9.04am, no lights would normally be on in either winter or summer, so this has no detrimental effect and allows a 2716 EPROM to be used. These are regarded as old hat nowadays and hence are inexpensive and quicker to program. A 2732 could have been used as it has 4096 addresses or memory locations, but the programs would have been twice. as long, and for those people without an automatic EPROM programmer, it is a lot of switches to activate to make the program normally (4096 ∞12 address ∞ 8 data combinations), as all the addresses should be programmed even if they are not used in the actual program.

When the Home Minder is not required on a day to day basis, the $\overline{\text{CE}}$ chip enable is used to disable the outputs but the counter and oscillator are kept running. To activate Home Minder, assuming it has been left on - i.e. zeroed at 4pm and left powered up, but disabled by the 'activate/deactivate' switch - just flick the switch to 'activate' and it's as simple as that. The outputs from the EPROM are now fed to the Darlington drivers in IC5 on the relay board between (4pm and 9am) which in turn switch the various circuits according to the program. The 'activate' switch can be switched on or off at any time, day or night. It has possibly crossed your mind as to why Home Minder is zeroed at 4pm. Well each of the two programs are 1023 minutes, long or 17 hours 3 minutes. In order to cover the evening, night and early morning for full winter coverage within this 17 hour band, all lights should be off by 9am so working back 17 hours comes to 4pm. In order to start the winter and summer programs at the same time, 4pm was chosen.

Channel 8 is used as a test signal, which flashes on for one minute every hour. If it comes on, on the hour you could never be sure which hour it was set to, because having a full clock display showing the time would have added to the complexity and cost when normally it is out of sight anyway. So, the test signal appears four minutes past four five minutes past five, six minutes past six and so on. so a simple check can be made that it is in step with the correct time. This test light does not work during 9am - 4pm because it works off Channel 8 which is disabled by $\overline{\text{OE}}$ after a count of 1024, but it is present between 4.04pm and 8.08am.

When 'Home Minder' has been on for several days it may be noticed that it is gaining or losing a few seconds a day. this can be confirmed by timing the test light from one day to the next using a good digital watch with a seconds display. Trimmer T1 on the oscillator can be adjusted to improve the accuracy. To start with, the trimmer is set to half way, at around 10p. This in parallel with the 10p C2 is the optimum value for the oscillator but a slight tweak may be necessary to improve matters.

Up to seven channels are programmable but without Channel 8 being used as the time test, this could be increased to 8. An extra relay is required and is connected like the others on the output of the Darlington driver pin 11. Diodes have been connected across the coils of the relays although this is not strictly needed because the Darlingtons have built in diodes but too many precautions are better than too few.

In practice we have found six channels quite enough to simulate the average family house - with too many lights flashing it more resembles a Christmas tree than a house.

Relays were chosen as the output switching devices as these can switch any voltage AC or DC. Fuses are fitted as standard on all channels for safety.

Opto triacs controlling power triacs could have been used instead of relays, but this would require a different PCB. The triacs should be fitted with small heatsinks. Isolated tab triacs should always be used as this reduces the amount of live metalwork, since the tab of a normal triac is connected to the output pin. Great care must be taken as they remain live at all times because power to them is brought in from the circuit being switched and not that supplied by the Home Minder via its mains supply. Fuses should still be used for ultimate safety on each channel, as for the relays.

Great care should also be taken when connecting up the outputs of the relays to the house lighting circuit. A diagram of a conventional lighting circuit is shown. This is a simple one switch circuit, the relay contacts are wired in parallel with the wall switch. Never get at the wires via the wall switch, always make the connections well out of the reach of everyone. Don't be surprised if the mains return is the side

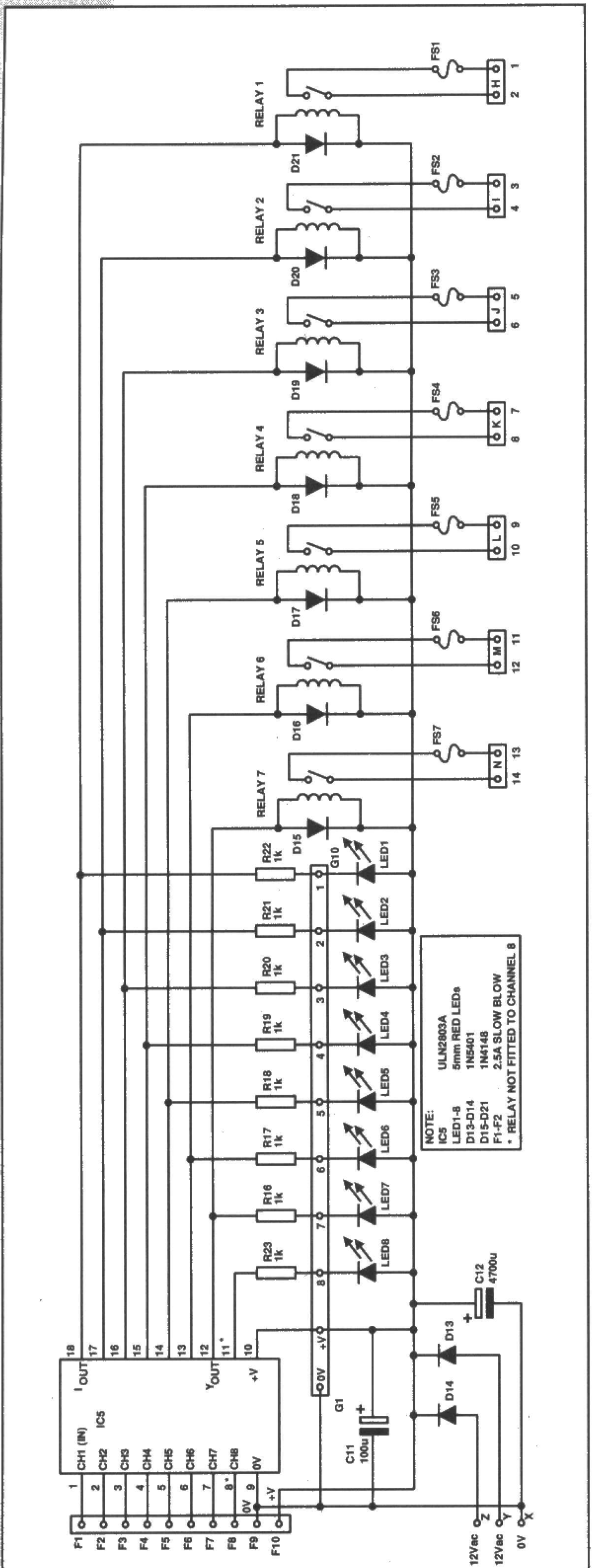


Fig.2 Relay Driver board circuit

that is switched. This is why a common live is not used in the circuit, but each output is completely independent of any of the others.

Again, it must be stressed that once connected the relay terminals and fuses remain live even if the Home Minder is unplugged from its mains supply, because the power is supplied all the time to the live side of the wall switch, or in our case, relay contacts. To connect into the lighting circuit, the mains master switch should be switched off - do not just remove the lighting fuse.

The relay contacts are intended to bypass the normal on/off switch on the wall to the light. They should not be used for two switch circuits normally found in halls/landings where the light can be turned on or off by either switch. There is no easy, safe way of connecting the relay contacts into this type of circuit (see diagram). In such cases another light should be wired up and run independently from the original light (as shown in the diagram). If you are in any doubt, contact a qualified electrician.

In our case, most of the wires were easily located in the loft for the upstairs and the front room was wired through a new cable to a wall socket which was activated by the relay, causing a standard lamp to come on.

Home Minder is mounted on the top shelf of the wardrobe and the wires connected up into the loft and on to the various lighting circuits. Each one was wired inside a covered 5A connector box - this means that there are no live wires exposed or odd pieces of connector block lying around in the loft. The connections that plug into the relay board are female types, so there are never live, unprotected pins. The pins are on the relay board (unpowered side) and even then, they are covered. Safety is vital in all aspects of mains wiring and no short cuts or economies with safety should ever be taken - if in any doubt at all seek expert advice.

When using Home Minder, neighbours and close trusted friends should be informed of its use if you're out or away, as they may call the Police thinking you have squatters - the effect is that real.

A full program listing is available for the running order to see if the program is suitable - even if it is not used in its entirety, at least it shows what is possible. The channels chosen - and their functions - can be changed to suit so long as the program is made accordingly. The music channel in our case switches a battery operated transistor radio tuned to Radio 2. It is not advisable to leave a television set running unattended and I would strongly dissuade anyone from doing so, although a mains radio would be OK.

A Test For Speed

From the interconnections diagram it can be seen that Q18 from the 4521 is brought out to a switch, 'Test/Normal'. This function allows the program to be run roughly sixty times faster than normal. The complete program can be run in this mode to test that everything is OK. It will show up things like all the channels coming on together because one location has not been programmed or if the EPROM is faulty. Although at this speed it still takes nearly half an hour to run a program, running it any faster it is hard to equate quite what is happening at any particular time. The Test/Normal switch can be mounted inside the Home Minder so that it's not accidentally switched during normal use. Once tested and proved OK, the zero button will still need to be pressed at 4pm because the counter will be out of step after running at

* SET TRIMMER CV1 TO MIDDLE TO START
THEN ADJUST TO CALIBRATE 24 HR CYCLE

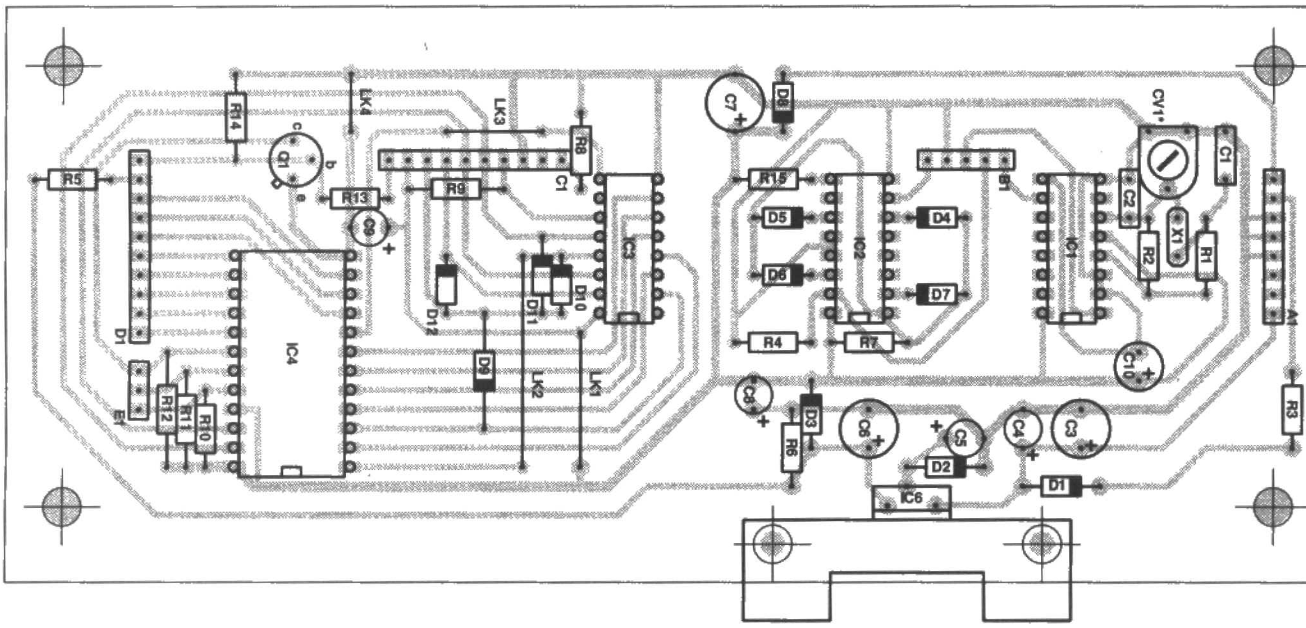


Fig.3 Component overlay for Main control board

the higher speed. The battery back up power switch can also be mounted inside the box so that it's not accidentally turned off.

Casing The Joints

Because of the physical size of this project, buying a suitable case to mount it in could cost a small fortune, so a home-made box was used instead. This was made out of 10-12 mm MDF (medium density fibreboard). It is a very easy material to work with as it has no grain or knots. Four pieces should be cut as per the drawing, although their exact sizes are not critical so long as they are compatible with each other and everything fits inside, leaving enough room for the wiring.

The front and back panels are made out of 16 swg aluminium sheet cut to size to fit inside the box, indented by 10mm to give a pleasing effect. They are mounted on a ledge of 12mm wide MDF - this, as well as forming a ledge front and back for mounting the panels, also adds to the strength of the box. All the MDF parts are glued using Evostik W resin glue rather than screws. This saves a lot of work filling over screw heads when finishing off. The front and back aluminium panels are drilled - a suggested front panel layout is given but this is not critical. The switch holes must suit the type of switches used, so only their centres are shown in the layout. Round hole mounted switches are a lot easier than oblong ones, unless you happen to have an oblong drill!

The panels can then be assembled and wired. A small bracket can be made to take the two internal switches ('Battery' and 'Fast/Normal') and should be mounted well away from the relay board so that the live mains on the fuses don't prove a problem if these switches are activated. It must be remembered that both the front and back panel must be earthed, as must the chassis of the mains transformer.

The PCBs are mounted on stand-off pillars. The main control board is screwed onto these pillars to lift the trackside of the board off the base of the case. Check that these screws are not too long and don't come out through the bottom of the case. The transformer is screwed down - a small piece of MDF can be glued to the base of the box inside to mount the transformer, which will enable longer screws to be used for holding it down.

The relay board is bolted to the rear panel, again on stand-off pillars. These should be at least 10mm long to keep the live connections of the track side of the relay board well away from the rear panel.

	Cannel 8		Channel7		Channel 6		Channel5		Channel4		Channel 3		Channel 2		Channel 1	
EPROM Out function	D7		D6		D5		D4		D3		D2		D1		D0	
EPROM Pin	17		16		15		14		13		11		10		9	
Control Output Pin	D1		D2		D3		D4		D5		D8		D7		D6	
Relay board input pin	F8		F7		F6		F5		F4		F3		F2		F1	
Relay No.	No Relay		7		6		5		4		3		2		1	
Function	Time Test		Not used		Music		Toilet		Landing		Bedroom		Front room		Outside	
Output pins			13	14	11	12	9	10	7	8	5	6	3	4	1	2
Darlington	8	11	7	12	6	13	5	14	4	15	3	16	2	17	1	18
LED Monitor	G3		G10		G9		G8		G7		G6		G5		G4	

The PCBs should have been fully tested before they are mounted - so a final check can be made that the relays and LEDs come on as expected. Before the lighting connections are made, the master mains switch should be turned off. The cables that come in through the back panel should do so through grommets to protect them from the sharp metal edges of the rear panel. As each of the lighting wires is added, it should be clearly marked with a label. A drawing should also be made as to which fuse and relay switch is which. This is helpful in years to come if a fault should occur or modifications are made to the wiring of the house. So often, something that seems obvious at the time seems anything but much later. The unit is then left on for a few hours and tests made to check there is no heat build up. It is now ready to be zeroed

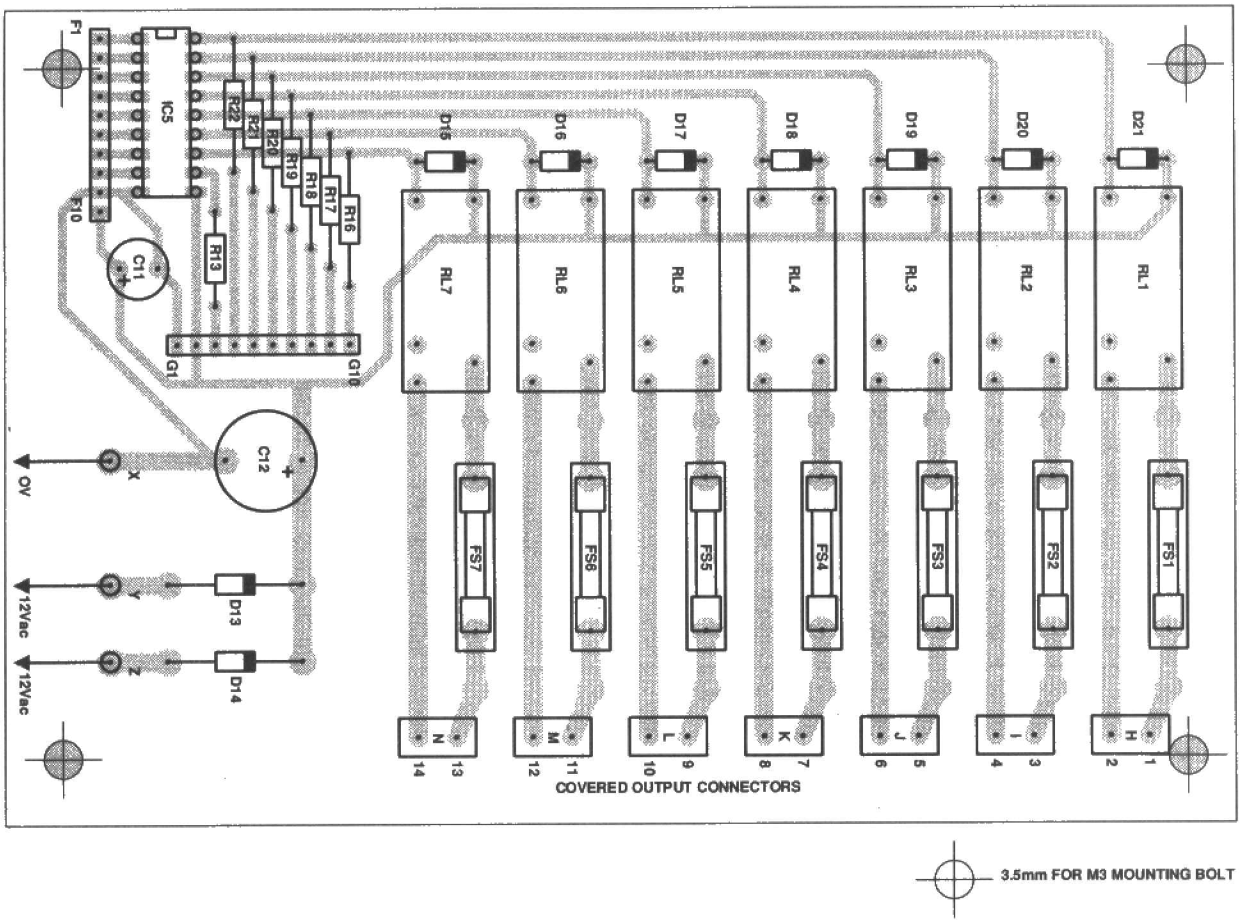


Fig.4 Component overlay for Relay board

	TIME TEST	NOT USED	MUSIC	TOILET	LANDING	BEDROOM	FRONT ROOM	OUTSIDE LIGHT	
EPROM FUNCTION	D7	D6	D5	D4	D3	D2	D1	D0	DATA CODE
CHANNEL	8	7	6	5	4	3	2	1	-
BINARY No.	D	C	B	A	D	C	B	A	
	0	0	1	0	0	0	0	1	21
	0	1	0	1		1	1	1	57
	1	0	0	1	1	0	1	0	9A
	0	0	0	0	1	0	1	1	0B
	0	1	0	0	1	1	0	0	4C
	1	0	0	0	1	1	0	1	8D
	0	0	1	1	1	1	1	0	3E
	0	1	1	0	1	1	1	1	5F

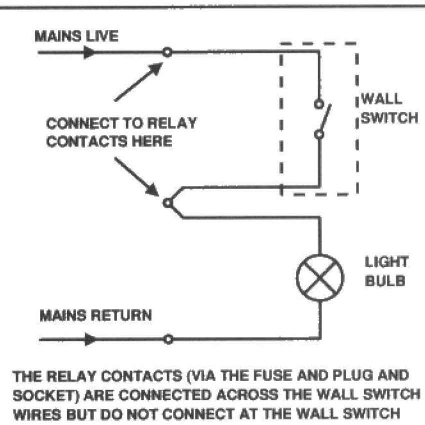


Fig.5 Mains lighting circuits

at 4pm and started using the 'Activate/Deactivate' switch.

Other Ideas

1. By connecting A10 of the EPROM to Q11 of the counter IC3 and disconnecting the connection from $\overline{Q11}$ on the counter IC3 to the EPROM OE and grounding OE on the EPROM, one full 24 hour program can be run which recycles every 1440 minutes or 24 hours. This has been used in a toy shop window display, to switch on and off various electrical toys, including 3 electric trains in every combination. The zero button can be pressed at various times so that different parts of the program are played at different times during the day and evening when people are passing.

2. Another idea put forward but not tried is that the unit is used in fast speed, the Test rather than the Normal is selected, and a robotic type toy can be programmed to move in time segments, i.e. 4 seconds forward, 2 seconds right, 7 left and so on. Here, the 16Hz divided by 15 gives slightly longer than one second time intervals, but by removing D4, D5, D6, D7, R7 and grounding pin 1 of IC2, IC2 now divides by 16. 16Hz from IC1 pin 10 divided by 16 in IC2 should produce a 1Hz pulse to the counter, advancing the program one step every second. The relay contacts are then used to switch the motors on the model causing it to follow the program.

By bringing out the major control signals to sockets, any number of options are available. Obviously, for both of these off shoot ideas, the program listing given will not be suitable.

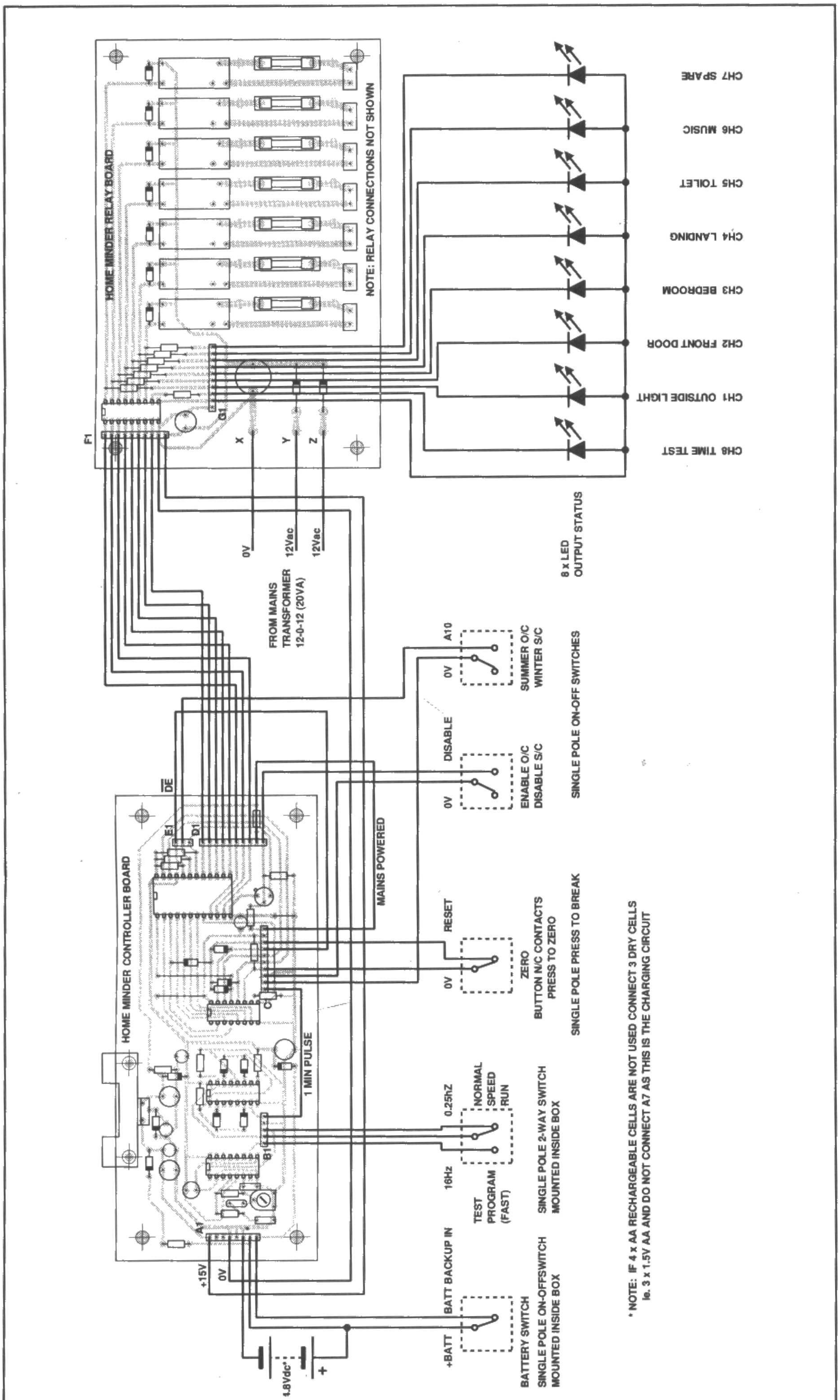
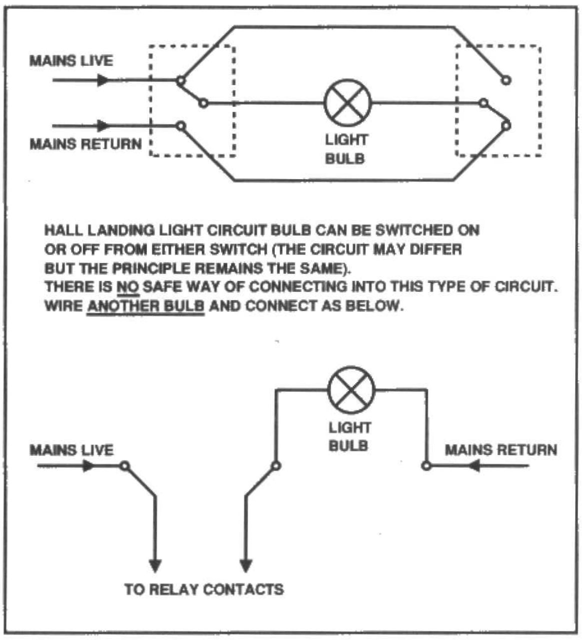


Fig.5 Board interconnections

WINTER PROGRAM			SUMMER PROGRAM		
TIME	ADDRESS	TEST TIME	ADDRESS	TEST TIME	TIME
4pm	ZERO WINTER AND SUMMER				4pm
4pm	0	04	1024	1028	4pm
5pm	60	65	1084	1089	5pm
6pm	120	126	1144	1150	6pm
7pm	180	187	1204	1211	7pm
8pm	240	248	1264	1272	8pm
9pm	300	309	1324	1333	9pm
10pm	360	370	1384	1394	10pm
11pm	420	431	1444	1455	11pm
12pm	480	492	1504	1516	12pm
1am	540	541	1564	1565	1am
2am	600	602	1624	1626	2am
3am	660	663	1684	1687	3am
4am	720	724	1744	1748	4am
5am	780	785	1804	1809	5am
6am	840	846	1864	1870	6am
7am	900	907	1924	1931	7am
8am	960	968	1984	1992	8am
9am	1020	*	2044	*	9am
9.04	OUTPUTS TURNED OFF TILL 4AM				9.04



Important Note

When buying components for this project it must be remembered that this circuit may well be switched on and left on for a very long time, so the components used should be of good quality and not reclaimed from other projects.

The mains transformer and smoothing capacitor should be new and from a reputable source. Some cheap transformers can get extremely hot when left on for any length of time and these should be avoided at all costs. Only use known dealers and suppliers for any of the major items.

The relays used are 12V coil with contacts that can switch 10A with a single pole change over contacts from Electromail. If any others are used it will pay to check that they fit the PCB before buying them. Several look the same but closer inspection shows their pin outs differ slightly.

The value of the fuses depends upon the circuit being switched, but 2.5A slow blow 1-1/4in should be sufficient in most cases. A slow blow type is recommended as there is an initial current surge when a light bulb is illuminated.

I can supply pre-recorded 2716 EPROMs with the summer and winter programs for £17.50 including postage and packing, but payment must be with order and in the form of a postal order or cheque made payable to Bob Noyes at the address below. Custom programs can be made, but their cost depends upon complexity, so write giving the listings and I can quote a price. Write to me at 13 Bowfell Close, Tilehurst, Reading, Berks. RG3 6QR.

A list of programming Hex codes for Summer and Winter are available by sending an SAE to the editor at the ETI offices.

PARTS LIST

RESISTORS

R1	2k2
R2	1M8
R3	2k7
R4,8	1M
R5,11,12,14	4k7
R6,7,9	10k
R10,13,15	10k
R16,17,18,19	1k
R20,21,22,23	1k

CAPACITORS

C1	82p
C2	10p
C3,8,11	100µ/25V
C4,6	2µ2/25V
C5,7,9,10	10µ/25V
C12	4700µ/25V

SEMICONDUCTORS

IC1	4521
IC2	4029
IC3	4040
IC4	2716 Programmed EPROM
IC5	2803A
Q1	BC107
REG1	7805
D1,2,3,8	1N4001
D4,5,6,7,9 10,11,12 15,16,17 18,19,20,21	1N4148
D13,14	1N5401

8 0.2in Red LEDs

MISCELLANEOUS

7 PCB straight headers 0.1in 10 way
7 Housings for above
1 pack of crimps for housings
Mains connector plugs on relay board
7 Horizontal PCB headers - 2 way
7 plugs for above - 2 way
7 Fuses 1 1/4in 2.5A slow blow
14 Fuse PCB holders (one each end)
7 Relays 12V DC coil SPCD
1 22p min trimmer
1 crystal 4.194304MHz
1 18 pin IC holder
1 16 pin IC holder
1 24 pin holder
1 Box to suit application
3 Single pole on/off switches, style to suit
1 Single pole 2 way switches, style to suit
1 Press button N/C contacts, style to suit
1 12-0-12V 20 VA transformer
2 PCB 1 x Main board, 1 x Relay board
4 1.2V AA rechargeable NJ cad batteries
1 4AA battery holder
1 Connector for above
8 Stand-off pillars to suit, 10 mm long

Enclosed electrical connectors (lighting style), number to suit Wire, mains plug, cable to suit application Heatsink, see layout. Size unimportant as 7805 does not get hot - used as a precaution - but the larger the better so long as it can be mounted securely.

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E93010-2	**Electronic Picture**	**H**
E93010-3	**Sega Box**	**J**
E93010-4	**Transister Amp (2 Boards)**	**N**
E93010-5	**Home Minder (2 Boards)**	**N**
E93010-FC	**Continuity Tester**	**D**

PCBs for the remaining projects are available from the companies listed in Buylines.
Use the form or a photocopy for your order. Please fill out all parts of the form. Make sure you use the board reference numbers. This not only identifies the board but also tells you when the project was published. The first two numbers are the year, the next two are the month.
Terms are strictly payment with order. We cannot accept official orders but we can supply a proforma invoice if required.
Such orders will not be processed until payment is received.

E9207-1	Improved Rear Bike Lamp	D
E9207-2	Mini Baby Bug Monitor	C
E9207-3	Ultrasonic Audio Sender (2 boards)	H
E9207-4	Camera Add-on unit (4 boards)	O
E9207-5	AutoMate 5V/48V Mixer power supply	J
E9207-6	AutoMate Precision 17V power supply	J
E9207-FC	Surround Sound Decoder	F
E9208-1	Dynamic Noise Limiter	F
E9208-2	Touch Controlled Intercom (2 boards)	H
E9208-3	MIDI Keyboard	K
E9208-FC	Battery charger	F
E9209-1	Intercom for light aircraft	H
E9209-2	Alarm protector	C
E9209-3	Temperature controller	M
E9209-FC	45W Hybrid power amp	F
E9210-1	Universal I/O Interface for PC (2 Sided)	N
E2910-2	Rapid Fuse Checker	E
E9210-3	Heartbeat/Audio Listener	E
E9210-FC	Wizards Hat	E
E9211-1	Electronic Die	E
E9211-FC	Car Alarm	F
E9212-1	Digital Circuit Tester	F
E9212-2	Communications Link by RS232	L
E9212-FC	Mains Inverter	E
E9301-2	Fading Festoonery	G
E9301-FC	Infra Red Receiver	F
E9302-1	EPROM Programmer (2 Sided)	N
E9302-2	Sound to MIDI Board	L
E9302-3	Puddle Tec	E
E9302-4	DiscoAmiga Light Selector	H
E9302-FC	Infra Red Transmitter	E
E9303-1	Ni-Cd Battery Charger	E
E9303-2	IC Tester	E
E9303-3	Disco Amiga (motor driver board)	H
E9303-4	Direct Conversion Reciever (2 Sided)	N
E9303-FC	LED Stoboscope	F
E9304-1	Solo Mic Pre-Amplifier	F
E9304-2	Multimate Tester	C
E9304-3	The Keepsafe Alarm	F
E9304-4	Proving Unit	E
E9304-5	Infra Guide Receiver Module	C
E9304-6	Infra Guide Transmitter	F
E9304-FC	(AutoMate) Peak Program Meter	F
E9305-1	Pentacode Main Board	F
E9305-2	Pentacode Relay Board	F
E9305-4	Vibration Detector	D
E9305-FC	The Fuzztone	E
E9306-1	Graphic Equaliser	F
E9306-2	Super Spooker	H
E9306-3	Middle & Side Stereo Coding	D
E9306-FC	The Chaperon	F
E9307-1	Car Battery Tester (Double Sided - Surface Mount)	E
E9307-2	Mind Trainer	F
E9307-FC	Microwave Monitor	F
E9308-1	Window Monitor (4 Boards)	K
E9308-2	Alternative 12V Supply	M
E9308-3	Single Channel Lumitec	E
E9308-4	Four Channel Lumitec	H
E9308-FC	Twi-light Zone	F
E9309-1	RF Signal Generator	F
E9309-2	MIDI Analyser CPU Board	K
E9309-3	MIDI Analyser Display Board	J
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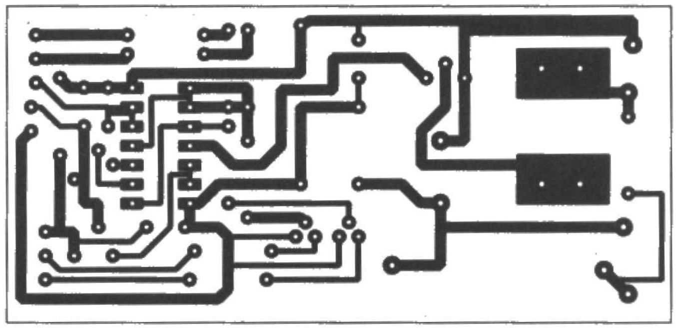

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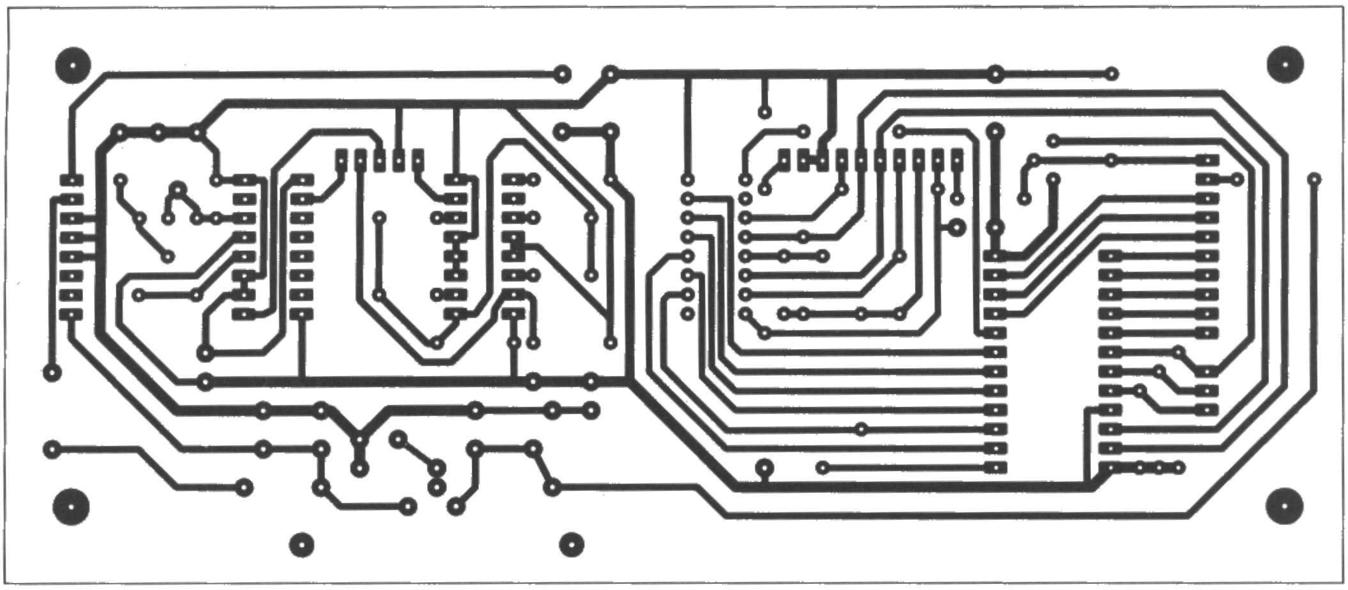
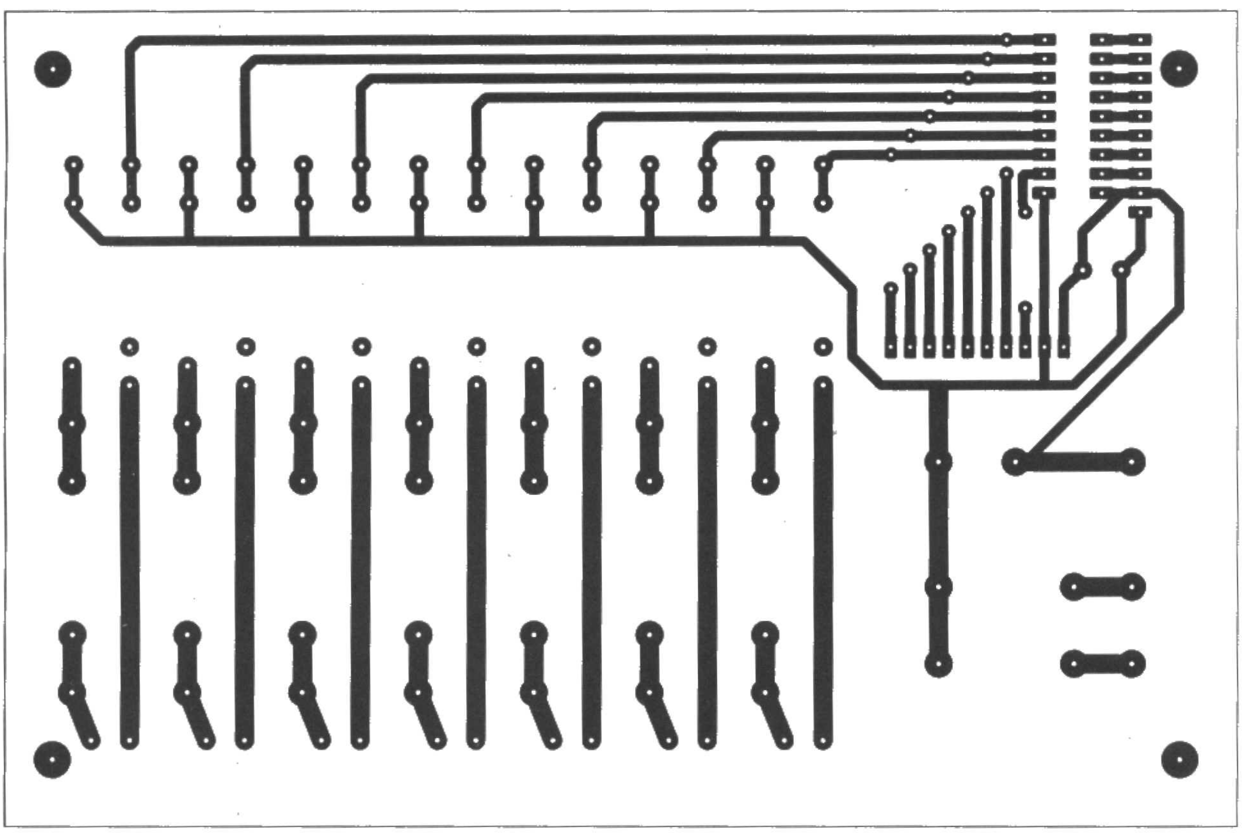
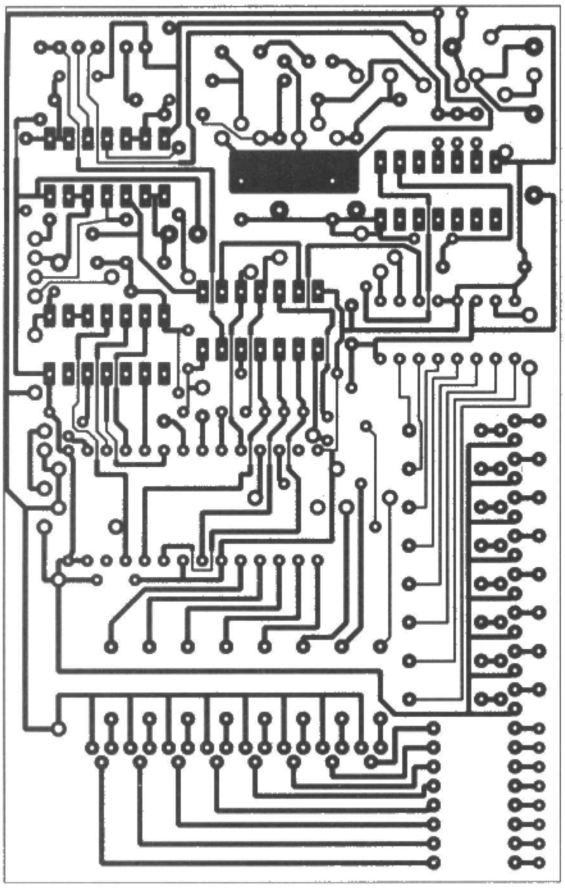
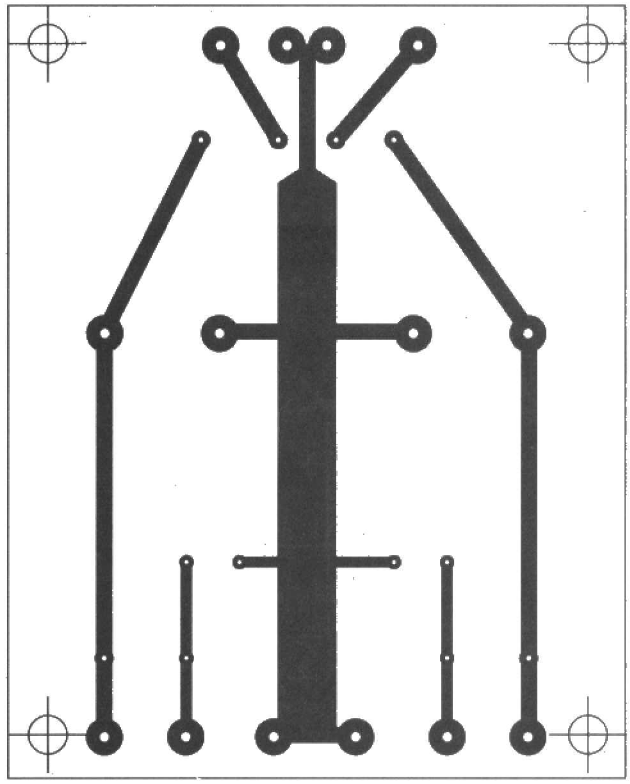




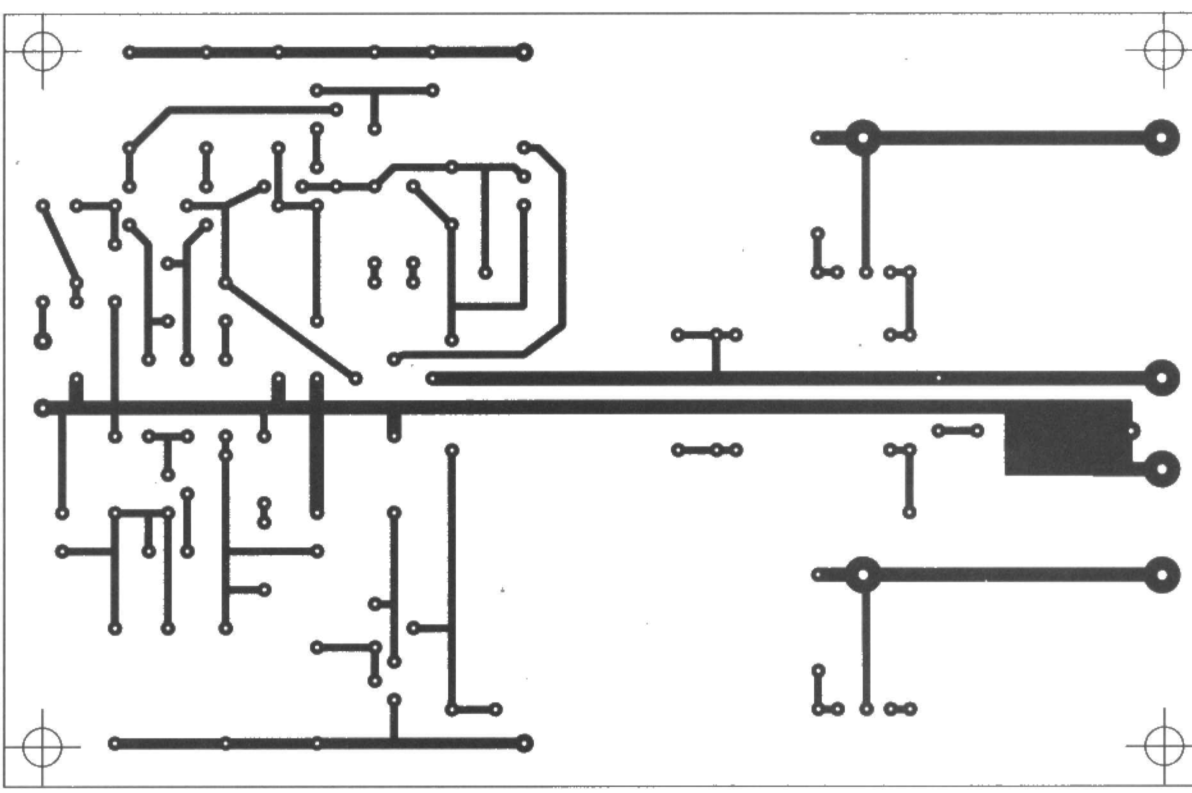
Home Minder



Electronic Picture



Transistor Amplifier Power Supply



Transistor Amplifier

FOILS